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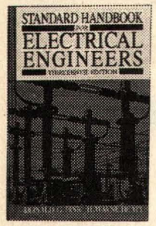
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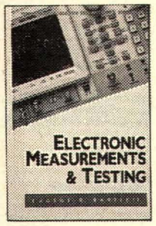
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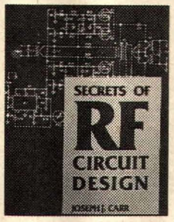
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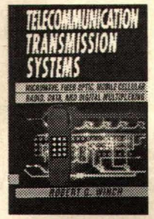
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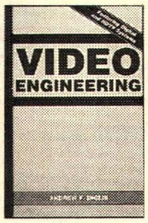
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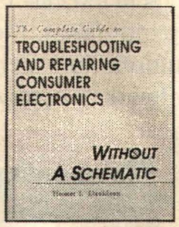
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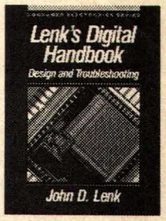
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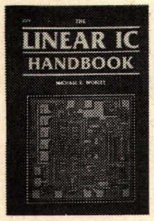
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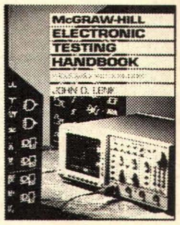
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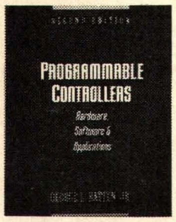
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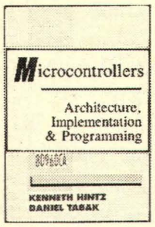
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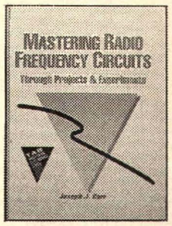
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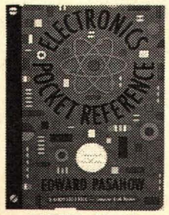
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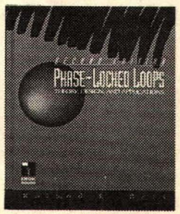
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ON THE COVER

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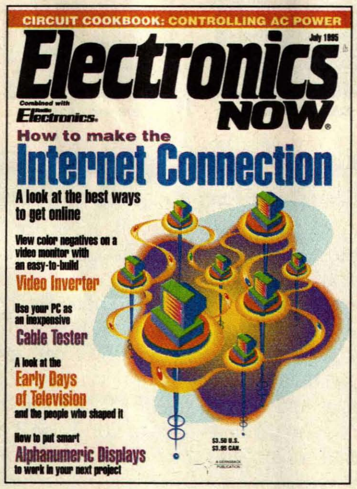
From its early beginnings in the late 1960s as a government networking experiment, the Internet has grown into a global information resource. The Internet is basically a network of computer networks, ranging from universities, to government institutions, to private industries. The Internet has something to offer for everyone, including individual computer users as well as businesses of all sizes. There are already over 30 million active internet users, and approximately 160,000 new users are accessing the Net each month. What exactly is the Internet, how can you benefit from it, and how do you get on it? Those questions and more are answered on page 31.

— *Stephen J. Bigelow*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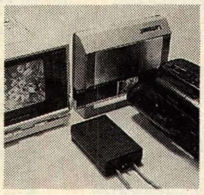

Invert your camcorder video output to view photographic negatives.

— *Joseph L. Sousa*

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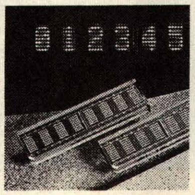

Learn how to program "smart" LED multicharacter displays.

— *Jerry R. Lettow*

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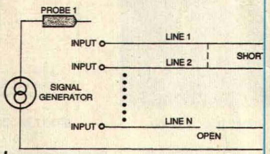

Let the power of your PC perform multipath continuity testing.

— *James J. Barbarello*

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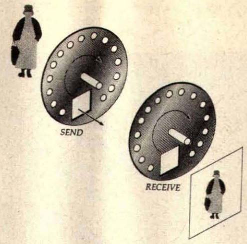

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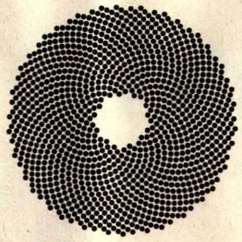

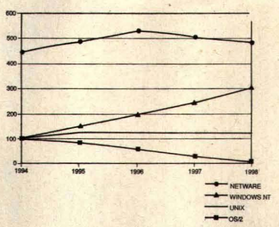

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WHAT'S NEWS

A review of the latest happenings in electronics.

World record in magnetic data-storage density

A team of researchers at IBM's Advanced Magnetic Recording Laboratory (San Jose, CA) has demonstrated a new world record in magnetic data-storage density—3 billion bits (3 gigabits) of data per square inch. Three billion bits is the equivalent of 187,500 double-spaced, typewritten pages. At that density, which is nearly five times that of today's most advanced disk drive, the text of 375 average-sized novels could be stored in a single square inch of disk surface.

The 3-gigabit demonstration did not require any radically new disk-drive technologies. The scientists used advanced versions of IBM's magnetoresistive (MR) recording heads and ultra-low-noise thin-film magnetic hard disks.

"Since the components used in this demonstration are evolutionary improvements on those we are already manufacturing in volume for IBM products, we're on track to providing 3-gigabit densities within the next three to five years," said Robert A. Scranton, director of recording head technology and manufacturing of the IBM Storage Products Company, which develops, manufactures, and sells disk drives.

In the 3-gigabit demonstration, bits were stored at a linear density of 180,000 bits per inch along concentric tracks packed at 16,500 per radial inch. Each data bit measures only 5.6 millionths of an inch in length by about 40 millionths of an inch wide—about one-quarter of the area of bit cells in current optical data-storage products.

The data bits are recorded onto a thin film of a magnetic cobalt alloy that coats an aluminum disk. The alloy's composition and fabrication conditions are designed for very high bit density and very low magnetic noise—critical advantages in reading the tiny bits. Another thin coating of a hard material protects the alloy film from contact with the recording head.

HUGO SANTINI, SENIOR ENGINEER, and Neil Robertson, manager of advanced head development, IBM Storage Products Company, use a scanning electron microscope to inspect an advanced magnetoresistive recording head for computer hard disks. Visible on the screen is a pattern of photoresist material that defines the coil of metal used to write data bits onto a magnetic hard disk. The heads also use a much smaller film of material that changes its electrical resistance in the presence of a magnetic field to read much smaller data bits than are possible by any other way.

During the demonstration, information was recorded and read at a data rate of 4.5 MB per second using IBM's "partial-response, maximum-likelihood" recording channel, which allows significantly greater bit densities than conventional "peak-detection" channels. The measured error rates were one in 10 billion, which would decrease to one in 10 trillion after standard error-correction codes were applied, meeting the stringent data-integrity requirements of the computer industry. That level of accuracy takes into account the fact that the head will not always be perfectly positioned over the data tracks, indicating that the system is capable of essentially flawless per-

Continued on page 29

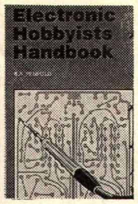
Electronics Experimenters' Books

Introducing
DIGITAL AUDIO
CD, DAT and Sampling
PC Publishing

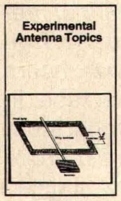
☐ **PCP116—Introducing Digital Audio—CD, DAT and Sampling... $10.00.** Digital audio involves methods and circuits that are totally alien to the technician or inquiring amateur who has previously worked with audio circuits. This book is intended to bridge the gap! The principles and methods are explained, but the mathematical background and theory are avoided when practical.

A Concise User's Guide to Windows 3.1

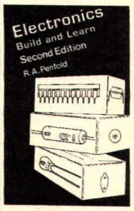
☐ **BP325—A Concise User's Guide to Windows 3.1...$7.95.** If you are having trouble with Windows 3.1, then discover how to manipulate Windows screens and how to run Windows and DOS applications under the Windows Graphic User Interface (GUI) environment. There's more: the word processor (Write), Program Manager, File Manager and Print Manager will be mastered by you. The text's scope is enormous.



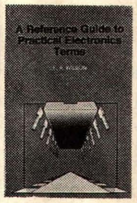
☐ **BP233—Electronic Hobbyists Handbook...$9.95.** A collection of data for the amateur electronics enthusiast. The text includes data on a multitude of topics such as parts color codes, integrated circuit pin-outs, transistor leadout diagrams and data, basic circuit building blocks, and much more. Where appropriate, detailed background information and explanatory notes are provided.



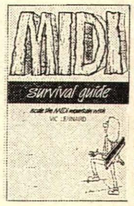
☐ **BP278—Experimental Antenna Topic ...$5.95.** Contains 28 fascinating sections and includes many unusual practical antenna designs that use such outlandish materials as cardboard, aluminum foil, plastic bottles, cat-food cans, etc., even water!



☐ **PCP104—Electronics—Build and Learn... $9.95.** Construction details are given to build a circuit demonstrator that is used throughout the book to introduce common electronic components and how these components are built up to useful circuits.



☐ **BP287—A Reference Guide to Practical Electronics Terms ...$8.95.** A companion volume to BP286. Covers the more practical and applied aspects of electronics. An essential reference work for the library of all those interested in electronics.



☐ **PCP118—MIDI Survival Guide...$7.75.** The book offers practical advice on starting up, setting up, and ending up with a practical MIDI system. Includes over 40 cabling diagrams and tips on connecting synths, sound modules, sequencers, etc.

Electronic Projects for
GUITAR

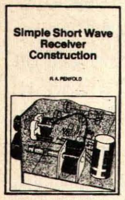
☐ **PCP117—Electronic Projects for Guitar...$12.95.** If you are a guitarist, you'll find this collection of 16 guitar and general-purpose effects projects extremely useful at bargain do-it-yourself prices. Each project has an introduction, an explanation of how it works, complete instruction on stripboard layout and assembly, as well as notes on setting it up and using. Written for the beginner project builder.

An Introduction to Loudspeakers and Enclosure Design

☐ **BP256—Introduction to Loudspeakers and Enclosure Design... $5.95.** All you need to know about the theory and operation of loudspeakers (drivers) and the various types of enclosures (boxes) into which they should be built. Crossover units are covered. Also includes the complete design and construction details of how to make an inexpensive but high-quality enclosure called the "Kapellmeister."

An Introduction to Satellite Television

☐ **BP195—An Introduction to Satellite Television...$9.95.** As an introduction to satellite television this book is presented on two levels. For the absolute beginner with no previous knowledge, the story is told as simply as it can be in the main text. For the professional engineer, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific details.



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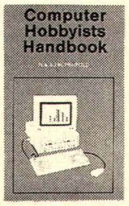

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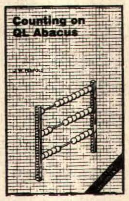

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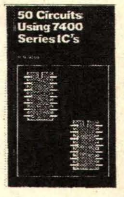

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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• Looking toward HDTV. High-definition TV broadcasting is beginning to look as if it might become reality, as networks start to make commitments to broadcast in the new standard. At the recent convention of the National Association of Broadcasters (NAB), NBC said that it planned to begin transmitting some prime-time programming in HDTV in 1997, and Fox and other networks began looking at the new reality of HDTV for the first time as something that would really come to pass. Demonstrations of the Grand Alliance system in action convinced most doubters that the American digital HDTV system could do the job. Broadcasters still would like to have the option of broadcasting several digital programs in standard definition on their channels, but there is less certainty that they could continue broadcasting both analog and digital signals on two channels for very long, because other potential spectrum users are eying the current TV space greedily, and the government would love the revenues that a spectrum auction could generate.

The first widescreen HDTV sets for the Grand Alliance system will go on sale in less than two years, Jerry Pearlman, chairman of Zenith Electronics, predicted at the NAB convention. He noted that three TV manufacturers that are members of the Grand Alliance—Philips, Thomson (RCA), and Zenith—account for half of the TV sets sold in the United States. He predicted that the first HDTV sets sold here would be capable of displaying the current analog standard definition signals along with digital HDTV. Pearlman forecast that PBS will be among the first HDTV broadcasters "and will experience an initial advantage" that could lead to long-range leadership." Pearlman noted that the success of Digital Satellite System broadcasts proves that consumers are willing to pay for better pictures and sound. "Consumers have been reading and hearing about HDTV for five years. Now they're ready to buy."

• Two digital VCRs. Formats might come and formats might go, but VHS goes on forever—at least that's the way JVC would like it. As the developer and proprietor of the standard home video-recording format, JVC has introduced many advances in the system while preserving compatibility. Conventional VHS led to VHS Hi-Fi, VHS-C (compact), S-VHS (super), and W-VHS (widescreen). The latest development is D-VHS—D for digital and data. JVC's newest sub-format continues to record and play back in standard analog mode, but also is capable of storing digital signals. The system already has been approved by most of the major VHS manufacturers.

JVC describes D-VHS as a "digital data server." It can record, store, and play back digital data, but cannot convert analog to digital data or vice versa. Using bitstream recording technology, it records compressed or processed signals on tape directly as digital data and outputs them in the same state as they were input.

The first use of D-VHS will be as a time-shift medium for the Digital Satellite System (DSS) as soon as an interface is developed. The D-VHS recorder will take digital signals from the DSS set-top box, record them, and on playback will feed them back into the same box for digital expansion, decoding and converting to analog form to be directed to the TV set.

Final specifications were still being developed at our deadline, but the system will record on a cassette similar in dimensions to a standard VHS cassette but containing S-VHS tape. It will have three recording modes. In STD mode, it will be capable of recording MPEG-2 encoded material, with a maximum input data rate of 14 megabits per second (Mbps), recording time of five hours (32.7 gigabytes capacity), or seven hours (44.7 gigabytes) using thin tape. In HD mode, with 28.2 Mbps input data rate, it will record for 2½ hours or 3½ hours with thin tape, and can record a digitally encoded high-definition program or six standard-definition programs simultaneously. LP mode, whose standards haven't yet been set, can record for up to 49 hours on a single cassette at 2 Mbps.

JVC says that it hopes to start producing D-VHS recorders late next year, with the United States as the first market, because the U.S. currently has the only digital TV system in use (DSS). The price will be 30,000 yen more than a standard VHS recorder, or about $350 additional, at our press time. The system isn't confined to TV, of course, but can record, store, and play back any digital data stream, responding to any format. As one JVC official said, "We don't change the signal. What goes in goes out."

• And also DVC. The digital videocassette (DVC) recorder approved by 50 of the world's hardware and tape manufacturers is still in the works. It differs from D-VCR not only in format and dimensions but in what it does, which is to record, store, and play back any analog or digital video signal in digital format. It will use ¼-inch-wide metal tape in cassettes of two sizes, and probably will appear first in a version for broadcast newsgathering (*Video News*, June 1995). Its first consumer use is expected to be in the form of a compact camcorder, capable of recording for 60 minutes (standard definition) on a

Continued on page 29

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VOLTAGE INDICATOR

I would like to build a circuit that displays the battery voltage level in my automobile. I'd like a bargraph consisting of about four LEDs that lights up as the voltage ranges between about 3 and 12 volts. I would also like to be able to set the trigger levels for the LEDs. Can you think of a simple circuit that would do this?—O. Vera, Mexico City, Mexico

I've lost count of the number of voltage monitors I've designed for use in cars, but this is the first time I've ever been asked about one that has to read down to 3 volts. Most monitors have a low value of about 11 volts—the lowest voltage you should ever see in a modern car's electrical system.

Because you want to monitor voltages that are much lower than a car's normal operating voltage, you can use a National Semiconductor LM339 comparator. That part is inexpensive and readily available. One strange characteristic of the LM339 is that, for reasons unknown, the power and ground pins are not in the standard upper left and bottom right positions; power is input at pin 3, and ground is connected to pin 12.

The simplest way to use the LM339 for your application is shown in Fig. 1. You will need as many of these circuits as the number of LEDs you want in your bargraph. The LED turns on when the input voltage at pin 5 of the LM339 falls below the reference voltage at pin 4. You can set the reference voltage for each stage of your bargraph by changing the value of the two resistors Ra and Rb that form the voltage divider at pin 4. The 5-kilohm trimmer potentiometer for the input voltage at pin 5 is optional, but it might help you set voltage levels exactly where you want them.

Because you're using this device in a car, I would suggest that you regulate the input voltage to the circuit because the voltage in an automobile is anything but constant. An LM7809 9-volt regulator would be a good choice.

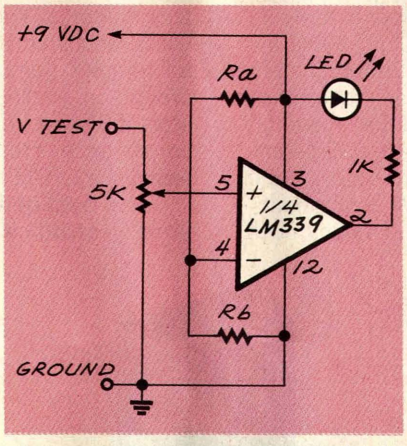

FIG. 1—VOLTAGE COMPARATOR circuit. The LED turns on when the input voltage at pin 5 of the LM339 falls below the reference voltage at pin 4.

There are four separate comparators in the LM339 package, so you can use one IC to monitor four different voltages. If you don't use one of the comparators in the chip, be sure to ground the inputs and outputs of the unused comparators or else they will tend to oscillate.

SIGNAL MONITOR

In our office we have a control line that sends a steady squarewave to various pieces of equipment configured in a daisy-chain arrangement. I need a circuit that will warn me when there's a loss of the control signal. There are commercial monitors available but they're expensive. Can I build a circuit that will do the same thing?—G. Benfer, Indy, NY

What you're asking for is a missing-pulse detector, and you can build one for about two bucks in parts. I'm sure that's a significant savings over the commercial units you mentioned.

A missing-pulse detector is a circuit whose output is triggered only if there's a loss of signal at its input. In the circuit shown in Fig. 2, the 555 timer IC is configured as a one-shot multivibrator that produces a pulse whose width is determined by the value of resistor R and capacitor C, shown in the schematic. The values for those parts can be calculated by using the formula T=1.1RC. You should select values that make the output pulses about twice as wide as the input trigger pulses from the control line. As long as there's a steady stream of input trigger pulses, the 555 will output a logic high. If there's a loslasts only for one input pulse period—the 555 will time out and its output will go logic low until the next trigger pulse arrives. The logic low at the 555 output can trigger an alarm, a time recorder, a counter, or any other device you want.

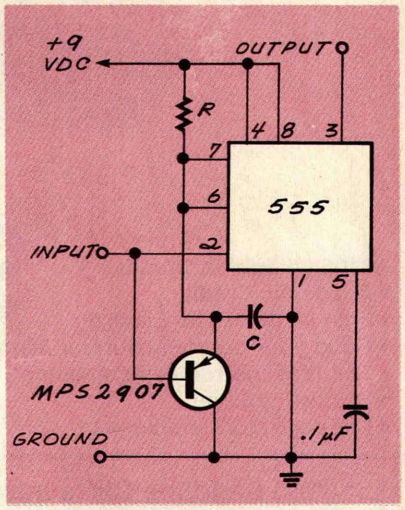

FIG. 2—A MISSING-PULSE DETECTOR triggers its output when there's a loss of signal at its input. Here the 555 timer IC is configured as a one-shot multivibrator that outputs a pulse whose width is determined by the value of resistor R and capacitor C.

NETWORK CARD SETTINGS

I'm setting up a small Novell network in my office, and I have to set the IRQ, the I/O base address, and the memory base ad-

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dress on the network card. I'm not sure what these settings are. Can you help?—R. Dorian, Trinity, NJ

Network cards are like any other device that must communicate with a computer. The card needs an interrupt request, or IRQ, so that it can signal the host computer when it needs to talk to it. When the network card generates its interrupt, the computer runs an interrupt servicing routine that lets it talk to the card, get data from the card, and then go back to what it was doing before the interrupt occurred.

The I/O base address lets the computer know where in its memory map the card is located. When your computer wants to communicate with the card, it has 65,535 possible I/O addresses to choose from, so the card must be set to a specific address, and the software that the computer uses to talk to the card must also know what the address is.

The memory base address is needed only if you have a workstation without any floppy- or hard-disk drives. In this case, you would have a PROM on the card containing a small program that can boot the computer and connect it to the network. If a computer does have any disk drives, the boot PROM is unnecessary, and the setting of the memory base address doesn't matter. It's good practice to set the address to the highest possible value (usually D800) because that's safely above the memory used for video.

The key factors in getting the card to work are to make sure the selected interrupt and I/O base address aren't used by any other device in your computer, and that the two parameters are set at the same values on the card and in the software.

LIGHT TURN ON

I built a circuit that turns on the lights on my night stands and it works great as long as the room is bright or dark. However, when there is some light in the room, the comparator goes into oscillation. I cannot find a way to stop it regardless of where the potentiometer is set. What should I do?—Emilio Ricciardelli

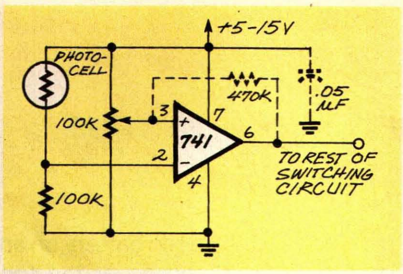

FIG. 3—THIS LIGHT TURN-ON CIRCUIT originally had oscillation problems. The 470K resistor introduces the hysteresis to prevent the oscillation.

What you need to do is add hysteresis—that is, make the turn-on and turn-off light levels slightly different, so that the circuit can't vacillate between them. Figure 3 shows your circuit as we breadboarded it. The 470K resistor introduces the hysteresis. If it's not enough, try 220K. With hysteresis, the comparator is now a Schmitt trigger.

Other hints: (1) Put a capacitor across the power supply, as close to the op-amp as possible; (2) use a 741 or TL081 op-amp rather than an LM339 comparator if you don't need high-speed operation.

ORGAN RESTORATION

I am starting to restore a 1948 electronic organ. Why does it use dual and triple "in a can" electrolytic capacitors instead of separate capacitors? What must I consider when replacing them?—Jack Dowell

Dual and triple electrolytics were used in order to save space. The can is connected to the negative terminal of all the capacitors in it. Fortunately, newer electrolytics are smaller and you can generally find room for them under the chassis, leaving the can in place (but disconnected) in order to preserve the original appearance.

The replacement filter capacitors should have equal or greater capacitance values and equal or greater voltage rating. Nowadays it's often practical to use a considerably larger capacitance than the original equipment did, thus reducing the amount of hum in the circuit. You can get high-voltage capacitors (and even some authentic "cans") from Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283.

LASER PHONOGRAPH

I have a large record collection dating from the '40s. Every time I play one of these gems, I feel guilty knowing the additional wear I'm imposing on the irreplaceable discs. Surely someone must have come up with a way of reading these records optically using laser technology and lenses, thereby preserving the records indefinitely. I can almost imagine coming up with something like that myself. Is there anything like this available?—John F. Leahy

It sounds like a good idea to us, too, but we've never seen one for sale. One was announced several years ago, but it never went on sale. One solution is to make the best possible recordings of the records, perhaps on digital audio tape, and then listen to only the recordings to preserve the records.

TV SCOPE

I need an oscilloscope but can't afford a real one. Do you have a simple circuit for converting a TV into an oscilloscope?—Angelo Garcia

See "Turn Your TV Screen Into an Oscilloscope," *Popular Electronics*, September, 1982, pp. 63–65. That circuit is entirely external to the TV; it uses a 555 as a pulse-width modulator synchronized with the TV's horizontal sweep to draw a trace vertically on the screen. The only problem is that it covers only low audio frequencies and is more of a novelty item than a practical test instrument.

Converting a TV into a full-function oscilloscope isn't practical. Because the TV picture tube uses magnetic rather than electrostatic deflection, frequency response would be poor. But you can go to a hamfest (ham radio swap meet) and pick up a used oscilloscope for $25 or less (possibly much less; I have been offered very old ones for free). See "New Life for Old Scopes," *Electronics Now*, September 1994. To find out about hamfests in your area, contact the local ham radio club or write to ARRL HQ, Newington, CT 06111. Ω

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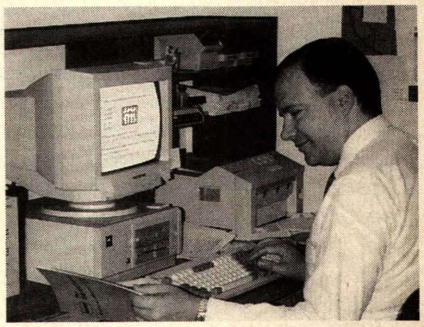

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MINIANALYZER UPDATE

A reader who built the Mini Logic Analyzer (Electronics Now, *February 1995, page 47) wanted to know why he saw multiple traces with a single input. The answer was given in the article, but it probably was not as clear as I thought it was when I wrote it. The third sentence in the second paragraph on page 82, under the heading "IC Checker," states: "Inputs 5 through 8 are grounded to avoid stray pickup."*

Grounding those pins follows the general rule about grounding unused inputs pins on ICs such as the CD4066B CMOS quad bilateral switch whose unused input pins become high-impedance pickup antennas in the off state. Alternatively, pull-down (terminating) resistors can be attached to each input.

Any value greater than 10 kilohms will work satisfactorily and not load the source circuitry. Those resistors can be permanently tack soldered in the circuit or they can be temporarily installed at the input leads.—James J. Barbarello

VOLTAGE CONVERTER CORRECTION

There is a consistent error in the pin numbering on the schematic symbol for the 555 timer IC in six of the figures in the "Voltage Converter" article (Electronics Now, *April 1995, page 42). In Figures 2,3,4,5,7, and 8 (pages 42, 43, and 44) the numbers identifying the pins on the left side of the symbol are incorrect. In all of those figures, the pin labeled "2" should be "7," and the pin labeled "7" should be "2."—Ray Marston*

FLORIDA HAMFEST

The Suncoast Amateur Radio Club will hold its Fifth Pasco County Hamfest on September 24, 1995, from 9:00 AM to 3:30 PM at the New Port Richey (Florida) Recreation Center. (The center is located about 25 miles north of Tampa, Florida). A W5YI testing session will be conducted, and an ARRL awards manager will be present to verify QSL cards for awards. The admission price is $5 at the door; children under 12 years of age will be admitted free.

Exhibitors' spaces that include a chair, a table, and the price of admission for one adult are available for $15. There is an extra charge of $5 for electric service at each table. Vendors must pre-register by contacting Tim, WD8MVU, at 1-813-848-0353 (The talk-in local frequency is 145.35 MHz; from long distance it is 147.150 MHz).

For more information, contact the Suncoast Amateur Radio Club at P. O. Box 1992, New Port Richey, FL 34656-1992.

DON NYSTROM, KA2KDP
Assistant Hamfest Coordinator
Port Richey, FL

MORE ON LEAD-ACID BATTERY DRAIN

Lead-acid batteries experience "concrete drain" because of the dust and moisture that accumulates on their top surfaces. This can be checked with a voltmeter. Connect the negative probe to the negative terminal of the battery and slowly drag the positive probe across the top toward the positive terminal. As the probe crosses each cell, the voltage reading will increase.

The reading could be as high as 10 volts on a 12-volt battery with a conductive film of dirt and moisture on its upper surface. This voltage is less likely to be found in batteries with side terminals.

Concrete floors on grade are known to "sweat" under certain conditions of temperature and relative humidity changes. This means that moisture migrates to the surface and is visible as wet patches. A battery left directly on a bare concrete floor will also sweat. That, reaction, along with dust settling on the battery top, can cause the voltage drain.

The way to solve the discharge problem is to store the battery on an insulating shelf, and cover the top so that dust cannot settle on it.

MIKE A. LEATHERWOOD
Alba, TX

Yes, current cannot leak out through the battery case unless the case is damaged. However, if the concrete floor on which the battery is stored is significantly warmer or colder than the air around the battery, the resulting temperature stratification in the liquid electrolyte can cause a slow discharge of the lead-acid battery.

GERALD PARK
Professor Emeritus of Electrical Engineering
Michigan State University

IN DEFENSE OF CSICOP

The letter from Benson Boss (*Electronics Now*, January 1995) condemning the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP) requires an answer. I will take on his points one by one:

1. He says that CSICOP condemns before investigating. Can he give me an example of that? CSICOP has investigated countless claims of paranormal events. In many cases, the claims have absolutely nothing but anecdotal evidence to support them.

Plenty of television talk shows provide a large audience for people who want to make fantastic claims. I certainly don't want CSICOP to join that parade. Just remember that the second and third words in CSICOP's title are "scientific investigation."

Mr. Boss claims that the committee picks on weak, absurd, and vulnerable reports of the paranormal. That probably represents most paranormal claims. Does he know about any paranormal event that CSICOP refuses to explore because that event could possibly be real? I'm sure CSICOP will pay particular attention to any paranormal claim that seems remarkable.

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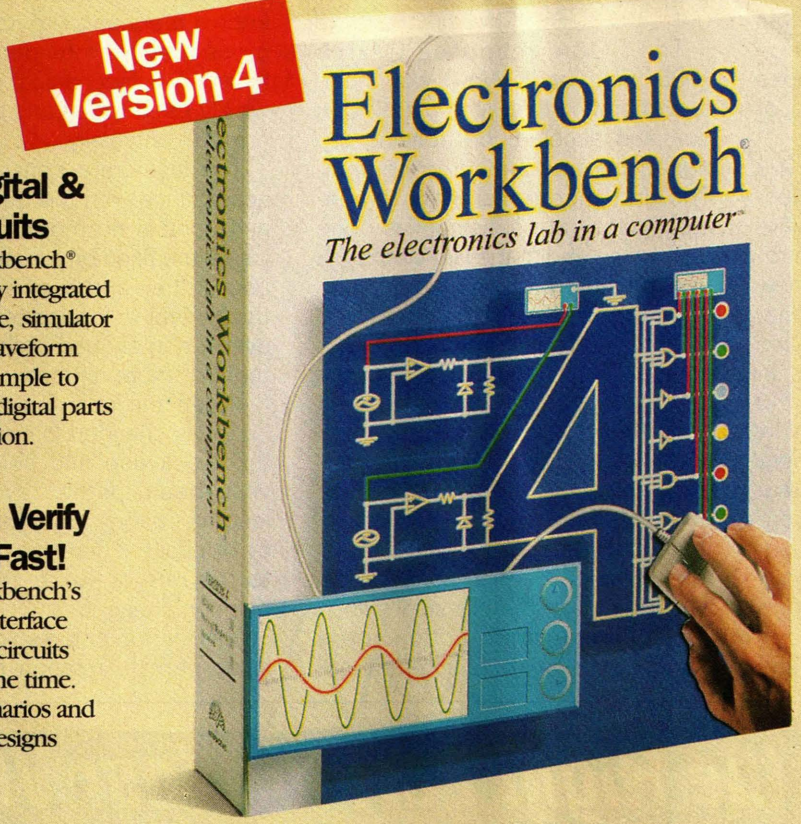

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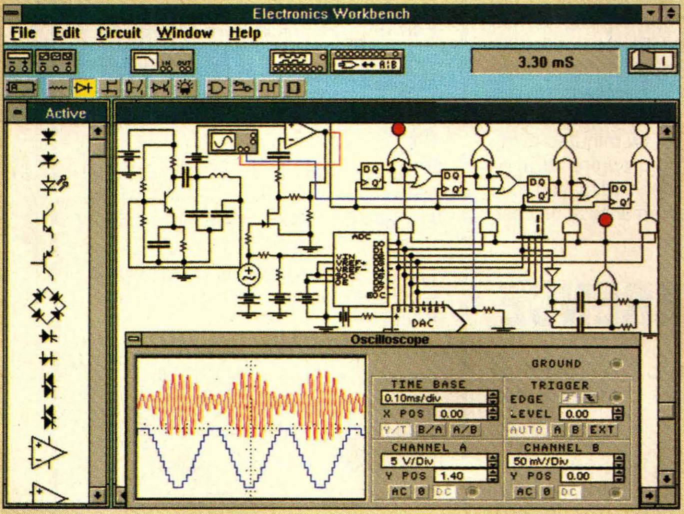

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CIRCLE 126 ON FREE INFORMATION CARD

Mr. Boss condemns CSICOP for demanding physical evidence to substantiate claims. But that's how it should be—no one who believes in the scientific method should ever settle for less. Anyone can make up a fantastic story. No organization could possibly investigate every idiotic claim made in a world that does not seem to have a shortage of crackpots.

Finally, Mr. Boss believes that it is professors, intellectuals, and scientists (the sort of people who make up CSICOP) who prevent the introduction of any fundamentally new ideas in politics, religion, medicine, and science. Well, just who *has* made the major contributions in those areas?

The readers of *Electronics Now* are interested in electronics. There is no doubt that the incredible advances being made in that field are being made by just the kind of people Mr. Boss thinks are too narrow-minded to achieve such accomplishments.

Everyone interested in learning about CSICOP should read its journal, *Skeptical Inquirer.*

RICHARD W. STICKA
Yorkville, IL

ROTATION AND ACCELERATION SENSING

The "Q&A" response (March 1995, *Electronics Now*) was incorrect in stating that all forms of rotation and acceleration sensing are based on mechanical principles. The first theoretical work in nonmechanical rate sensing was done toward the end of the last century. It was the result of studies in interferometry and research done by a scientist named Sagnac. (An effect named for him is the basis for work in nonmechanical sensing being done today.)

Practical applications of nonmechanical acceleration and angular rate sensing date back more than 20 years. Laser and fiber-optic rate sensors (Sagnac sensors) do not depend on the classical principles of gyroscopic action, pendulous movement, tuning-fork oscillation, gimballed suspension, or displacement of a physical mass.

Unfortunately, the frequently used terms "laser gyro" and "fiber-optic gyro" are misnomers and are misleading. They defer to the better known mechanical gyroscope because they are intended to replace them. The mechanical gyro is still widely used today and is being improved continually.

The laser rate sensors work in accordance with the Sagnac effect and contain no moving parts. Two lasers are fixed on a base relative to each other and they emit beams that travel in opposite directions over a ring-shaped path formed by three or more mirrors.

When the position of this light "ring" is changed in inertial space, the clockwise and counterclockwise beam paths have different lengths so they produce a frequency or phase difference proportional to the rate at which the sensor's position changes.

This instrument, also called a ring laser, permits rotation to be mea-

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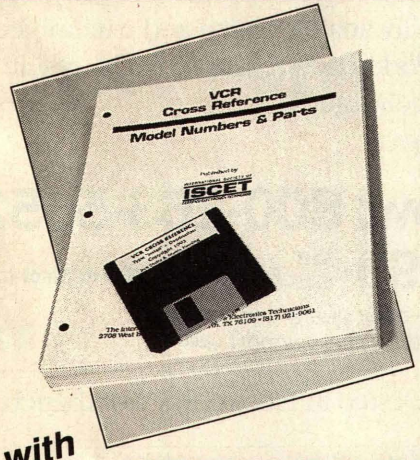

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sured without a spinning mechanical mass. The laser beam phase relationship can be sensed by an interferometer or detected by a photomultiplier or other device capable of measuring changes in light intensity accurately.

I know about proprietary work being done on these instruments by companies about 15 years ago. They applied the ring laser concept to solid-state, optical fiber gyros and accelerometers. The principal elements were fine glass optical fibers wound on tiny spools the size of a dime.

At that time, the experimental prototypes based on those optical fiber spools achieved only about 10% of the accuracy required for a practical guidance system. However, the developers were confident that they could achieve the required accuracy within 10 to 15 years.

These instruments were intended for guiding "Star Wars" interceptor projectiles which were to be about five inches in diameter and 10 to 12 inches long. I was also aware of other R&D that made use of even more exotic means for sensing acceleration—again without mechanical components. I have yet to see those concepts described in any publication in the public domain, so I can only assume that they are still classified.

Laser gyros have been installed in commercial and military aircraft for more than ten years. Some of those instruments are mounted in gimballed platforms and others are directly mounted to the frame of the host vehicle.

THOMAS REDDIE
Las Vegas, NV

BATTERY ISOLATOR COMMENTS

I want to comment on Randal Christman's question about using a battery isolator to maintain the charge on two batteries from one alternator ("Q&A," *Electronics Now*, April 1995). Modern, well designed voltage regulators for controlling an alternator are set for an output of 14.2 to 14.4 volts DC because a typical lead-acid cell requires roughly 2.4 volts DC per cell to charge it.

When a battery isolator is installed, the voltage drop across the diodes will be about 0.5 to 0.6 volt DC. That drops the voltage across the battery to a value that is too low to charge a battery fully. A replacement adjustable voltage regulator should be a part of the system.

One way to obtain the diodes is to remove the plates from a discarded alternator. You will obtain an adequate heatsink, but the diodes should still be mounted where air can flow freely around them.

In the same Q&A column, Larry Bell asked about a lead-acid battery losing its charge when stored on a bare concrete floor. That might have been a problem several decades ago when battery cases were made from hard rubber. The moisture migrates from damp concrete up the sides of the case causing electrical leakage and eventually discharges the battery. This is no longer a problem with modern batteries packaged in plastic cases because of their better insulation properties.

NEIL DENNIS
Bliss, NY

Ω

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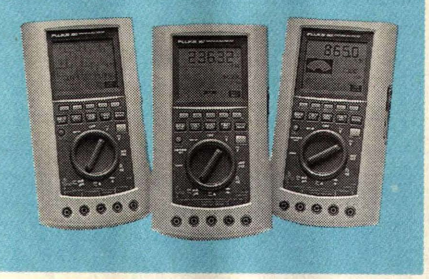

Fluke Corporation, long known for its innovations in multimeters, has introduced its new 860 series of Graphical Multimeters (GMM). These instruments combine the functions of a digital multimeter with those of an oscilloscope, an in-circuit component tester, a trend plotter, and a logic activity detector—all in a single handheld, battery-powered package. Clearly these meters have more to offer than the under $100 run-of-the-mill DMMs. With price tags that range from $795 to $1295, they are positioned well into the professional class.

The three meters in the 860 series all look the same and all are packaged in the same yellow cases. A multifunction liquid-crystal displays occupies about one third of the top surfaces. Controls include the now well accepted rotary switch accompanied by rows of supplementary pushbuttons. These instruments have the feel of heavy-duty meters that can take some roughing up without a whimper; for all their sophistication, they are not pale laboratory bench wimps.

The 860 series GMM test tools are intended for troubleshooting, maintenance, installation, and calibration of industrial and medical equipment. They are also suitable for the repair and maintenance of computers, office machines, communications equipment, and consumer electronics.

All three of the 860 models contain a basic "core" of performance features that set them apart from all other digital multimeters on the market. Two of the higher priced models have additional supplementary features. This gives the customer who has decided that he needs a high-performance DMM the opportunity to see what he can get for the higher price tags and determine whether those features will pay off.

The lowest-priced Model 863 offers 32,000-count (4.5 digit) resolution, a dual digital display, and an simulated moving-needle analog display —the better to spot trends. The Model 863 can measure AC voltage to 1000 volts (over 20 to 300 Hz) and DC voltage to 1000 volts. It can also measure ohms to 30 megohms, AC and DC current to 10 amperes, and frequency to 2 MHz. Capacitance can be measured over the range of 10 nanofarads to 10,000 microfarads, and present readings in decibels. It has a basic DC accuracy of 0.04%. Alkaline batteries are included with this model.

The Model 865 picks up where the Model 863 left off by offering such extra features as in-circuit component test and logic test. While retaining the same 0.04 % DC accuracy, it is able to measure frequency to greater than 10 MHz. It also has internal battery charging, waveform memory, and a combined line-voltage adapter and battery charger. Its LCD display is backlit, and alkaline batteries is included.

The top of the line Model 867 offers higher 0.025% DC accuracy. Picking up where the Model 865 left off, it includes an optically isolated RS-232 cable and the software that will permit it to be interfaced with a printer or personal computer. This model includes a rechargeable nickel-cadmium battery pack in place of the alkaline batteries.

Twenty-three years ago, the then John Fluke Mfg. Co. put most of the circuitry of one of its benchtop DMMs on two custom-made IC chips and revolutionized the industry. Before long much of that circuitry had migrated to a single silicon single chip and the semiconductor manufacturers who had made them decided to recover some of their costs by selling the formerly custom devices to other instrument manufacturers.

The availability of the single-chip IC that contained the crucial inner workings of the DMM for a low price opened the door for the new class of pocket-sized, handheld, battery-powered DMMs that offered most of the features obtainable only in expensive benchtop models from a few well known American manufacturers. In this clear example of "trickle-down of advanced features," handheld meters priced under $100 were soon doing what only the $300 to $500 benchtop models could do.

This turn of events impacted heavily on American instrument manufacturers who had been making benchtop DMMs. If they wanted to stay in the business where prices were falling, they had the options of manufacturing offshore or building automated facilities to continue manufacture in the U.S.A. Faced with this prospect some dropped out. But Fluke was one of the companies that elected to stay and fight. It built an expensive, largely automated facility for manufacturing DMMs in this country, and emphasized its reputation for quality and customer service.

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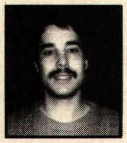

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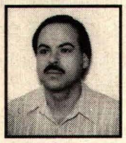

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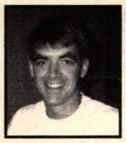

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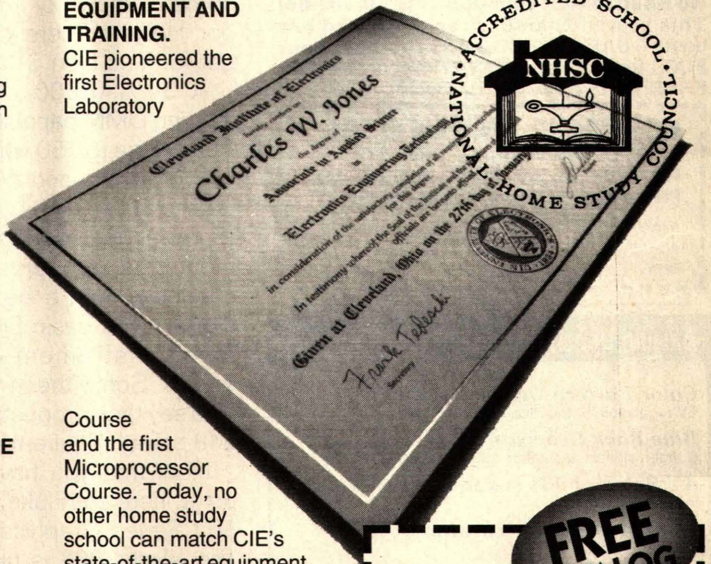

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multimeters indicate another direction that Fluke took—adding features that were beyond the capabilities of the offshore manufacturers of handheld DMMs. Obviously the prices went up, but the company banked on retaining its customer base. Soon the low-cost microcontroller made many other features such as the multipurpose LCD feasible and cost-effective.

For comparison purposes, it is interesting to see what one can get for less than $100 in DMMs today. Integrated circuitry available on the open market put a substantial floor under their performance. Needless to say, it's necessary to invoke that old warning "buyer beware" when purchasing a low cost meter from some unknown or little known vendor. However, here is what you can get for less than $100 today.

A 3--¾ (3200 count) manual ranging DMM capable of measuring AC voltage to 750 volts, DC voltage to 1000 volts, and AC and DC current to 10 amperes. Many are able to measure resistance over 20 megohms, preserve data, check continuity with a beeper, and test diodes. The basic DC accuracy of these instruments is typically 0.25%. Some these manufacturers also say their products meet the IEC 348 safety requirements.

Now that you have a reference point, here are Fluke's prices for its 860 Series Graphical Multimeters. The Model 863 is priced at $795, the Model 865 is priced at $995 and the Model 867 is priced at $1295. (Fluke Corporation, PO Box 9090, Everett, WA 98206, Phone: 800-44-FLUKE, Fax: 206-356-5116.)

860 operating modes

The meter mode presents both a digital readout and a simulated analog moving-needle display. In this mode one can measure current, resistance, continuity, conductance, capacitance, frequency, duty cycle, pulse width, period, dB, and AC and DC voltage. A numeric readout supplements the analog needle.

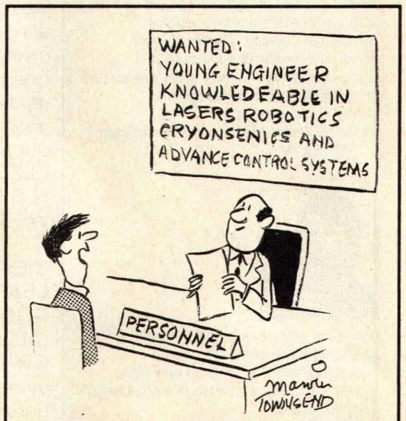
The waveform display provides a clear graph of noise, waveform distortion, intermittent failures, and glitches. This mode can display signals with bandwidths up to 1 MHz. This enhances the numeric display by providing qualitative information about a signal. The Full Auto display setup automatically scales voltage, timebase, triggering, and position. Manual setup or external triggering are also possible.

The Trendgraph mode plots high resolution meter readings for up to 30 hours, in intervals from 1 second to 15 minutes. It can detect power sags, surges, and droops.

The in-circuit component test permits component signatures to be viewed while the component remains in the circuit. Consequently no time and effort is wasted in removing and handling components, some of which might be sensitive and subject to damage during removal. This feature permits users to troubleshoot problems by comparing component signatures of known, functioning circuits with those of defective circuits. Components can be checked without having to power up the circuit.

The Fluke 860 Series Graphical Multimeters are obviously not for everyone who analyzes faults and services electronic equipment and appliances. The meters are all premium priced and premium quality instruments.

For those who really need the performance features offered, these instruments are probably inexpensive, and they certainly will be cost-effective because you won't need to tote along another set of test instruments. The low-cost, foreign made DMMs are just not in the same league —and that's without mentioning the graphical modes. Ω



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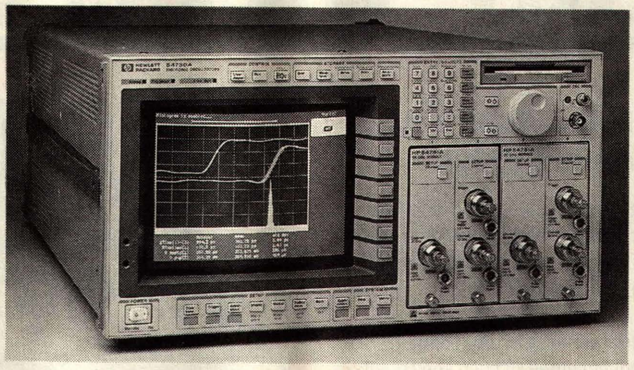

CIRCLE 20 ON FREE INFORMATION CARD

WIDE-BANDWIDTH OSCILLOSCOPE. Hewlett-Packard has introduced its HP 5470A 20-GHz repetitive sampling oscilloscope. It is said to be two to three times faster than comparable wideband oscilloscopes when it is operated either by front-panel controls or a remote computer.

The HP 5470A oscilloscope is intended for such assignments as testing high-frequency circuits and devices in automated test systems and characterizing and modeling electronic devices and circuits in development laboratories.

Fast throughput permits measurements to be made more rapidly, thus increasing productivity. The HP 5470A has a bandwidth of DC to 20-GHz. Its 17.5-picosecond risetime permits the viewing and analysis of fast-rising waveform edges. Moreover, its 5-picosecond time-interval accuracy combined with 62.5-femtosecond timing resolution permit precise timing analysis and jitter characterization.

The oscilloscope can make more than 50 measurements automatically, thus reducing manual set-up time. Its features include FFTs, color-graded displays, histograms, limit testing, mask testing, and full parametric characterization of multivalued waveforms, and human eye diagrams.

A modular platform, the HP 5470A accepts up to two dual-channel plug-in modules. The HP 5475A has two independent vertical channels with bandwidth selectable from 12.4GHz to 20 GHz. An optional software package includes the firmware for supporting the HP 83480 series of optical to electrical plug-ins. These add standard telecommunications mask templates and permit automatic optical/human eye pattern measurements.

The HP 5470A oscilloscope is priced at $16,000.00; the HP 5471A dual-channel plug-in module is priced at $8500.00, and the HP 83480K+ communications software package is priced at $1500.00

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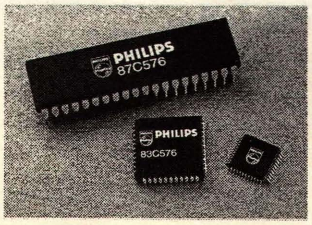
Direct Marketing Organization
P. O. Box 58059, MS51L-SJ
Santa Clara, CA 95051-8059
Phone: 1-800-542-4844, ext. 8809



CIRCLE 21 ON FREE INFORMATION CARD

80C51-BASED MICROCONTROLLER. The 8XC576 imicrocontroller from Philips Semiconductors includes a universal peripheral interface (UPI) and a 10-bit analog to digital converter. Intended for such applications as automotive and industrial controls, data communications, instrumentation, computer and peripheral systems, and cellular telephone networks, the IC will simplify circuit board design and reduce the number of components. It will also increase the reliability of its host system and reduce its EMI and RFI emissions.

The 8XC576 includes 8 kilobytes of ROM/EPROM, 256 bytes of RAM, and three 16-bit counter timers. Other on-chip functions include a programmable counter array, a "watchdog" timer, analog comparators, enhanced UART, and two pulse-width modulated outputs. Also on the IC are power- and oscillator-fail detection, user-programmable outputs, and Schmitt trigger inputs.

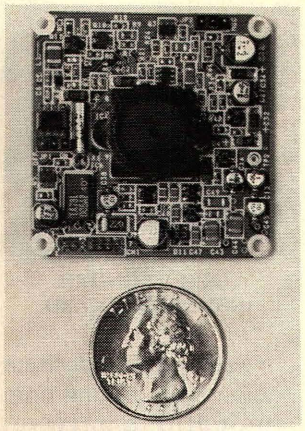
Two versions are available: the 83C576 with ROM, and the 87C576 with EPROM or one-time only programmable EPROM. Packaging options include dial-in-line (DIP), leadless chip carrier (LCC), and plastic quad flatpack (QPF).

The 83C576 is priced at $4.90 in quantities of 5000.

Philips Semiconductors
811 East Arques Avenue
P. O. Box 3408
Sunnyvale, CA
94088-3409
Phone: 800-447-1500, ext. 3000

PIN-HOLE VIDEO CAMERA. The Model PH-380 black and white video camera from Northeast Micro Electronics can view an entire room through a ⅛-inch diameter hole in a wall or furniture. Built on a 1¾-inch square substrate, the tiny camera offers 380 lines of resolution and low-light sensitivity of 0.5 lux. Its automatic adjustment features include electronic iris and gain control.

Intended primarily for security systems, PH-380 might be useful whenever there is a need for a small unobtrusive video camera.



CIRCLE 22 ON FREE INFORMATION CARD

It is powered from 12 volts DC, and can be wired directly to any video monitor or most VCRs.

The PH-380 video camera with a ⅛-inch diameter lens is priced at $215.00

Northeast Micro Electronics
P. O. Box 175
Elmwood Park, NJ 07407
Phone: 201-794-1132, ext. 826
Fax: 201-797-6464

SOLID-STATE MOBILE AMPLIFIER. The ALS-500M solid-state amplifier from Ameritron produces 500 watts of output power over the 1.5 to 222-MHz band. It offers instant bandswitching, requires no tuning or warmup, and it is standing wave ratio (SWR) protected. Four high power linear RF power transistors are in the circuitry.

CIRCLE 23 ON FREE INFORMATION CARD

The ALS-500M requires 13.8 volts DC at 80 amperes peak current and a separate line for 12 to 15 volts DC and 4 amperes for control and bias circuits. The amplifier's front panel controls include a frequency switch, an ON-OFF power switch and a DC ammeter. It can operate in the 10/12 meter band with the installation of an optional conversion kit.

The amplifier is protected by load-fault protection circuitry that disables and bypasses the amplifier if the antenna reflects excessively high power or if the bandswitch is set lower than its exciter frequency. Thermal overload protection disables and bypasses the amplifier if the temperature exceeds a safe level. The amplifier automatically resets when the temperature falls below that value.

The ALS-500M amplifier is priced at $799.00, and the optional 10/12-meter kit is priced at $29.95.

Ameritron
921 Willow Road
Starksville, MS 39759
Phone: 601-323-8211
Fax: 601-323-6551

TELEPHONE-RING GENERATOR MODULE. The RG12V/6R ringing generator circuit from Jec Tech generates a ringing voltage of 90-volt peak (180 volts peak-to-peak). The ringing frequency can be varied from 15 to 68 Hz by adjusting an included potentiometer. This permits the module to be set to simulate any type of ringing listed in Part 68 of the FCC rules. It is powered from 12 volts DC.

Intended for integration into OEM products and systems requiring a ringing function, the RG12V/6R has a control lead that turns the generator on with a low (ground) from an external open collector or relay contacts. Occupying a volume of 2×2.4×0.75-inches high, the generator module is in a single-in-line (SIP) package.

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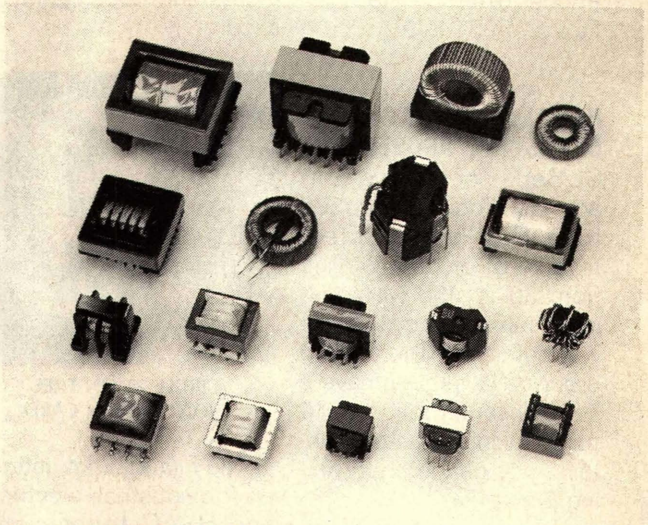

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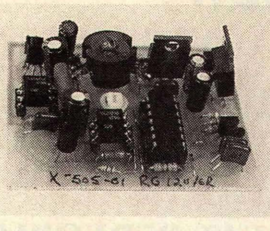


CIRCLE 24 ON FREE INFORMATION CARD

tically or horizontally on a circuit board with the hardware supplied. The module's switched 5-volt output can power other circuits whose current drain is 50 milliamperes or less. The RG12V/6R will ring up to six 1-ampere ringers. It is factory set at 20-Hz, but that frequency can be varied for use in countries whose telephone systems do not conform to the 20-Hz American and Canadian standard.

The RG12V/6R telephone-ring generator module is priced at $49.95 plus $3.00 additional for shipping and handling.

Jec Tech
12962 Olde Post Road
Pickerington, OH 43147
Phone: 614-927-3495
Fax: 614-927-3494

PASSIVE-VOLTAGE OSCILLOSCOPE PROBES. The SL-Series of passive-voltage oscilloscope probes from ITT Pomona Electronics offer bandwidths from 30 to 450 MHz and input capacitance as low as 7 picofarads (for a ×10 probe). The probes have a compensation range of 10 to 30 picofarads to maintain test signal integrity during probe use.

CIRCLE 25 ON FREE INFORMATION CARD

The probes are made from durable thermoplastic that complies with the IEC1010 safety standards. Each probe has a replaceable gold-plated test tip and a cable that is 48-inches long. Versions with switchable attenuation of 1×/10× are also available.

SL-Series probes are priced from $33.00 to $49.00, depending on bandwidth.

ITT Pomona Electronics
1500 East Ninth Street
Pomona, CA 91766-3835
Phone: 1-800-241-2060
Fax: 909-629-3317

SERVICE KITS. Two new digital multimeter service kits have been introduced by Fluke. The Fluke 23 and Fluke 87 service kits include a handheld DMM, and all the accessories and training documentation needed to make accurate electrical measurements efficiently. The kits offer significant discounts over the purchase of the instruments and documentation separately.

CIRCLE 26 ON FREE INFORMATION CARD

The Fluke 23 kit, intended for industrial, electrical, and HVAC technicians, contains a Model 23 analog and digital display multimeter, an 80i-400 clamp-on AC current probe, a TL20 test lead set, and a case.The kit also includes application notes and training materials.

The Fluke 87 kit includes a Model 87 analog and digital multimeter, an 80i-400 clamp-on AC current probe, a TL20 test-lead set, a carrying case, and a video entitled "Understanding Harmonics." Other training materials included are the "High Performance Guide to DMMs" application booklet and electrical, harmonic, and HVAC/R application notes.

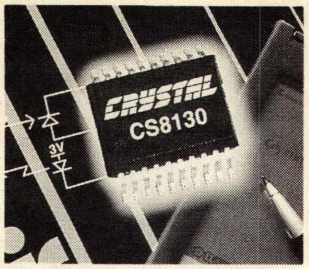
The Fluke 23 service kit is priced at $309.00, and the Fluke 87 kit is priced at $469.00.

Fluke Corporation
P. O. Box 9090
Everett, WA 98206
Phone: 800-44-FLUKE
Fax: 206-356-5116

MULTI-STANDARD INFRARED TRANSCEIVER IC. The CS8130 multi-standard infrared transceiver IC from Crystal Semiconductor is designed to conform to the new Infrared Data Association (IrDA) standard for "cordless" communications. It is intended for installation in desktop, laptop, and notebook PCs; personal digital assistants; printers; network nodes; telephones; and fax machines to permit data exchange between these products.

The transceiver can be connected to a standard UART with standard TxD, RxD, and two handshake pins. On the IR side, a standard LED and PIN diode are attached directly to the device. The IC also contains a baud clock generator and programmable registers that allow the setting of various options. The CS8130 will transfer data at standard UART baud rates of 2400-bits per second up to 115.2 kilobits per second, in half- or full-duplex mode.

The IrDA standard is intended as a worldwide IR



CIRCLE 27 ON FREE INFORMATION CARD

connectivity standard capable of supporting communications between equipment made by different manufacturers in different countries.

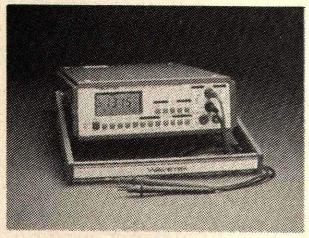
The chip supports the Sharp 500-kHz ASK mode, 38-kHz ASK TV remote mode, and a direct (no modulation or decoding) mode. Thus a Sharp personal digital assistant (PDA) with a CS8130 could transfer data to an Apple Newton or a Sharp Wizard.

The CS8130 in a 20-pin SSOP package is priced at $5.50 each in 1000 quantity. A CDB8130 evaluation kit that includes two demonstration boards which attach to standard COM ports, software, and documentation, is also available.

Crystal Semiconductor Corporation
P. O. Box 17847
Austin, TX 78760
Phone: 512-442-7555
Fax: 512-445-7581

BENCHTOP DIGITAL MULTIMETER. The Model BDM35 3¾-digit (4000 count) benchtop digital multimeter from Wavetek can measure DC and AC voltage, current, and resistance as well as frequency and capacitance. It can also perform diode testing and audible continuity checks. Its liquid crystal display has half-inch high characters and a 42-segment bargraph.

The BDM35 can measure AC and DC volotage to 750/1000 volts in five ranges, AC and DC current in five ranges to 20 amperes, and resistance in six ranges to 40 megohms. The meter is autoranging and all functions can be selected with front panel pushbuttons. The basic DC accuracy of the meter is ±0.1%.



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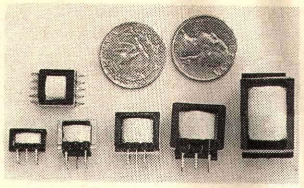
The meter's troubleshooting features include Min/Max Record for recording the highest or lowest readings over a time period, Mem/Read that records the meter's last function and measurement in that function, and Hold that freezes the display for later viewing.

The BDM35 benchtop multimeter with test leads, power cord and an instruction manual is priced at $369.00.

Wavetek Corporation
9145 Balboa Avenue
San Diego, CA 92123
Phone: 619-279-2200

28,800-BPS MODEM-COUPLING TRANSFORMER. Low-profile T14Z coupling transformers from Integrity Technology are intended for 28.8-kilobit per second (Kbps) CCITT V.34 data transmission applications. Measuring only 0.49 ×0.57×0.52-inches, the transformers can be connected directly to 600-ohm telephone lines with zero DC bias, in "dry" modem circuits.

The cores of the transformers are made with Z11 Parmalloy metal, molded phenolic bobbins, and hard copper pins. They are intended for use in fax machines, modems, answering machines, silent alarms, and credit-card verification machines.



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The T14Z transformers are priced at 69 cents each in volume buys.

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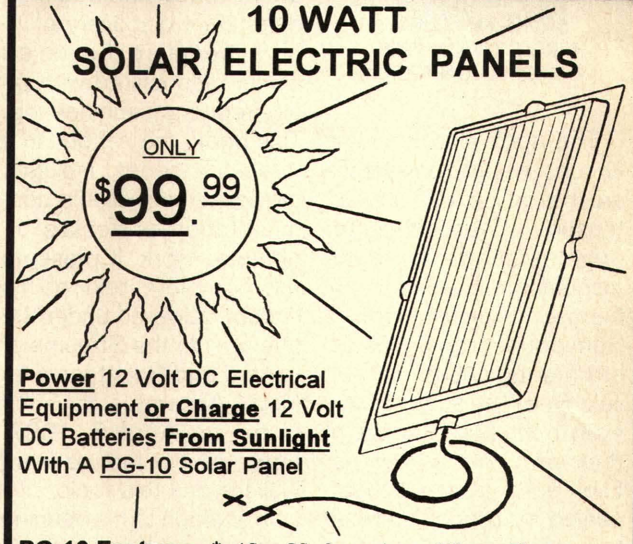

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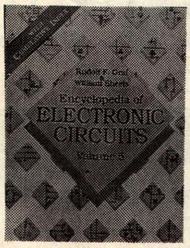
Encyclopedia of Electronic Circuits, Volume 5; by Rudolf F. Graf and William Sheets. Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128; $34.95.

This is the fifth volume in a series of collections of circuit diagrams and their descriptions obtained primarily from various publications including *Electronics Now* and semiconductor manufacturers' applications notes. It adds more than 1000 circuit designs to the collection of circuit designs in the authors' previous four volumes.



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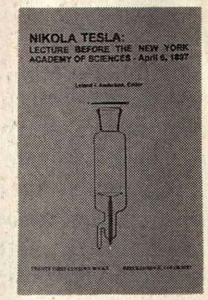
The book also contains circuits whose operations are based on the characteristics of semiconductor devices made by such manufacturers as National Semiconductor, Harris Semiconductor, Texas Instruments, Motorola, and Teledyne. The authors have even contributed some of their own circuit designs. Each schematic is accompanied by a brief explanation of circuit operation and, where useful, information about such subjects as adjustment or alignment.

The volume is organized in alphabetical order into 135 categories, and it contains a cumulative index that covers all of the circuits and data published in the previous four books in the series. The categories in Volume 5 include alarm and security systems, audio amplifiers, computers, frequency meters, gas and smoke detectors, oscilloscopes, receivers, waveform generators, temperature sensors, and video amplifiers.

Nikola Tesla: Lecture Before the New York Academy of Sciences—April 6, 1897; edited by Leland I. Anderson. Twenty First Century Books, P. O. Box 2001, Breckenridge, CO 80424-2001; Phone: 303-453-9293; $21.95 in hardcoverand $12.95 in paperback.

Many persons are unaware of Nikola Tesla's independent discovery of X-rays because he is so closely associated with radio-frequency engineering. This book, the second in a three-part series, includes previously unavailable documentation of Tesla's pioneering work. It presents the complete text of his lecture delivered under the title of "On the Streams of Lenard and Roentgen with Novel Apparatus for Their Use" on April 6, 1897. However, the lecture went well beyond this topic.

In addition to his opening remarks on X-ray discovery, a major portion of Tesla's commentary deals with the high-frequency resonators that he used in his work. He also describes the stroboscopic instruments he designed for measurement of frequency and phase. During the talk, Tesla showed about 120 drawings of vacuum tubes, including those of the Lenard type and a single-electrode type he designed. Some of the tubes were used in his wireless communications experiments.


NIKOLA TESLA:
LECTURE BEFORE THE NEW YORK ACADEMY OF SCIENCES - April 6, 1897
Leland I. Anderson, Editor

CIRCLE 338 ON FREE INFORMATION CARD

Other topics covered in this book are wireless receiving methods and Tesla's particle beam device of 1937.Computer-enhanced photographs of the drawings are among the 32 illustrations included in the book.

1995 ARRL Handbook for Radio Amateurs; edited by Robert Schetgen, KU7G. The American Radio Relay League, 225 Main Street, Newington, CT 06111; Phone: 203-666-1541; Fax: 203-665-7531; $30.

For decades, the ARRL Handbook has been the Bible of the radio amateur, and it has proven to be a useful reference for amateurs as well as professionals with an interest in radio communications. More than six million copies have been sold since it was first published in 1926.

This 72nd edition is a complete revision of all previous editions. It has been reorganized for easier reading, and now includes chapters on technology that is now influencing amateurs and will have greater impact in the future. The subjects include the theory of analog electronics, transceivers, repeaters, digital signal processing, building circuits, transmission lines, antennas, and propagation.

THE ARRL
HANDBOOK
FOR RADIO AMATEURS
1995

CIRCLE 339 ON FREE INFORMATION CARD

Chapters of the handbook explain how to organize and test an amateur radio station and how to build circuits related to the amateur radio hobby such as power supplies, transceivers, and amplifiers. The "Modes" chapter reviews the different ways hams communicate, from Morse code to digitized voice transmission.

Modern oscillators and synthesizers are explained, and "Mathematics for Amateur Radio" is a refresher course in the mathematics of most use to the radio amateur. Tables and charts related to common electronic phenomena and principles will help the reader to find needed answers faster than by calculation from formulas.

1995 Catalog. Parts Express, 340 East First Street, Dayton, OH 45402; Phone: 1-800-338-0531; Fax: 513-222-0173; 212 pages; free.

This latest catalog from Parts Express contains descriptions and pictures of the electronic parts and accessories offered by this distributor. It emphasizes consumer-electronics products and parts for the electronics hobbyist.

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Among the many items included are speakers and audio accessories for the home and car, audio products for building into the home or office, and cable TV and VCR repair replacement parts and accessories. Also covered are semiconductors, tools, chemicals and solvents for electronics servicing, computer accessories, telephone-related products, wire, connectors, books, and videotapes.

Connecting to the Future: Creating Environmentally Safe Chemical Products for Manufacturing, Maintenance & Service. Caig Laboratories, Inc., 16744 West Bernardo Drive, San Diego, CA 92127-1904; Phone: 1-800-CAIG-123 or 619-451-1799; Fax: 619-451-2799; free.

This is a catalog from a company that specializes in chemicals for electronics manufacturing and maintenance. Caig claims its cleaning products are safer for the environment and pose less hazard to the user than the toxic chemical solutions previously used for cleaning components and circuit boards.

CAIG LABORATORIES, INC.
CONNECTING to the FUTURE
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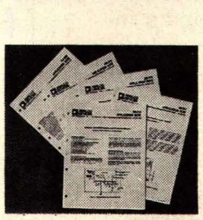
CIRCLE 341 ON FREE INFORMATION CARD

A complete line of concentrated formulations that are applied by wiping, pens, and needle and syringe dispensers rather than aerosol cans are described. Some preparations are suited for cleaning connector pins and contacts. Other products are deoxidizers, preservatives, lubricants, anti-static solutions, solvents and cutting oils.

ADXL50 Accelerometer Application Notes. Analog Devices Literature Center, 70 Shawmut Road, Canton, MA 02021; Fax: 617-821-4273; free.

This is a book of five application notes about Analog Devices' ADXL50 monolithic accelerometer. The ADXL50 is said to be the first combined acceleration sensor and signal-conditioning circuit on a single silicon substrate. The notes offer practical solutions to a wide range of acceleration measurement applications.



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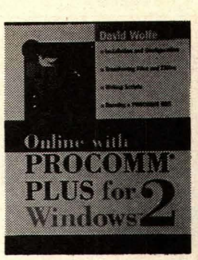
- AN-376 *Using the ADXL50EM* explains the electrical and mechanical characteristics of the AD accelerometer.
- AN377 *Increasing the Frequency Response of the ADXL50* explains how the accelerometer's frequency response is increased from 1.3 kHz to 10 kHz.
- AN-378 *Reducing the Average Power Consumption of the ADXL50* explains techniques for conserving power to the device.
- AN-379, *Mounting Considerations for the ADXL50* explains how to mount the accelerometer
- AN-380 *Compensating for the 0–g Offset Drift of the ADXL50* explains how to compensate for unavoidable zero-point drift.

Online with PROCOMM Plus for Windows 2; by David Wolfe. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Phone: 1-800-CALL-WILEY; $22.95.

To get on Internet one needs three things: a personal computer, a modem, and understandable communications software that is easy to use. PROCOMM Plus is a popular software package for PC users, but many who have purchased it have run into difficulties in installing, configuring, and running the program. This book makes it easier for Windows users to make the necessary online connections.

Written for PROCOMM users with all levels of PC experience, Wolfe's book explains how even beginners can master the program, including installation, customization, and speeding up file transfers. Advanced topics include the use of PROCOMM's built-in programming language, external protocols, and troubleshooting modem hardware problems.



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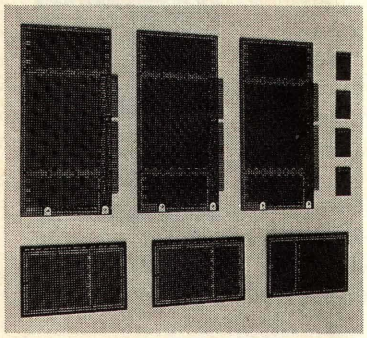
Included are explanations of how to create fax sheets with graphic icons, transfer files, send faxes, and view graphics as they are downloaded. Instructions are given in designing personalized graphical user interfaces with the program's Window builder and dialog editor. You will also learn how to use ASPECT to automate PROCOMM and put it to work running BBS.

Signal Conditioners Design Guide 1995. Calex Manufacturing Company, Inc., 2401 Stanwell Drive, Concord, CA 94520; Phone: 800-542-3355; Fax: 510-687-3333; 176 pages; free.

This catalog illustrates and describes the wide variety of products offered by Calex. Included are modular load cell and strain-gage signal conditioners, DC-isolated transmitters, constant-current sources, alarms, and DC differential amplifiers. Also included are DC/DC converters and linear power supplies for powering Calex instrumentation modules.

The catalog includes



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CALEX
SIGNAL CONDITIONERS
DESIGN GUIDE 1995

CIRCLE 344 ON FREE INFORMATION CARD

specifications, circuit and block diagrams, descriptions, performance curves, application information, and a selection guide.

The subjects of the application notes include grounding and shielding techniques and how to reduce transmitter EMI. Price and ordering information is included.

Power-Pak Primer #1. Conversion Devices, Inc., 15 Jonathan Drive, Brockton, MA 02401; Phone: 508-559-0880; Fax: 508-559-9288; 4 pages; free.

This Conversion Devices technical note discusses the advantages and disadvantages of both central and distributed power systems.

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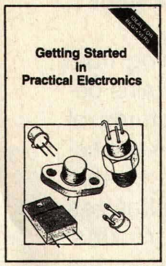
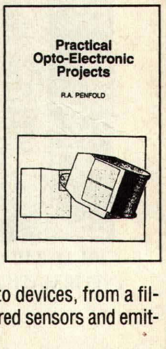
The book defines both central power and distributed-power architectures, and explains the impact of each on electronic designs. Topics include time to market, system control and monitoring, power distribution, and system modification.

Circuit diagrams and tables included in the technical note illustrate important subjects. Ω

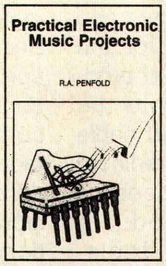
You can Build Gadgets!
Here are 3 reasons why!



☐ **BP345—GETTING STARTED IN PRACTICAL ELECTRONICS $5.95**
If you are looking into launching an exciting hobby activity, this text provides minimum essentials for the builder and 30 easy-to-build fun projects every experimenter should toy with. Printed-circuit board designs are included to give your project a professional appearance.



☐ **BP349—PRACTICAL OPTO-ELECTRONIC PROJECTS $5.95**
If you shun opto-electronic projects for lack of knowledge, this is the book for you. A bit of introductory theory comes first and then a number of practical projects which utilize a range of opto devices, from a filament bulb to modern infrared sensors and emitters—all are easy to build.



☐ **BP363—PRACTICAL ELECTRONIC MUSIC PROJECTS $5.95**
The text contains a goodly number of practical music projects most often requested by musicians. All the projects are relatively low-in-cost to build and all use standard, readily-available components that you can buy. The project categories are guitar, general music and MIDI.

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Address ______________________
City ______________State ____ZIP ______
Please allow 6-8 weeks for delivery.

VIDEO NEWS

continued from page 6

cassette the size of a DAT cassette.

DVC recorders will be capable of recording in the bitstream mode, but will also be sold with analog-to-digital and digital-to-analog encoders, making it possible to record analog video signals digitally and feed them to an analog TV for playback. The 50-manufacturer DVC group recently agreed to specs for recording and storing the Grand Alliance HDTV system. One of the most difficult problems in developing the digital recording system was providing for special effects. In the HDTV mode, it will record a separate low-definition signal for special effects.

DVC camcorders could start appearing early in 1996. Home DVC recorders will accept either the small camcorder cassette or a larger one (about the size of an audio cassette box) that can record for 4½ hours in standard definition. Ω

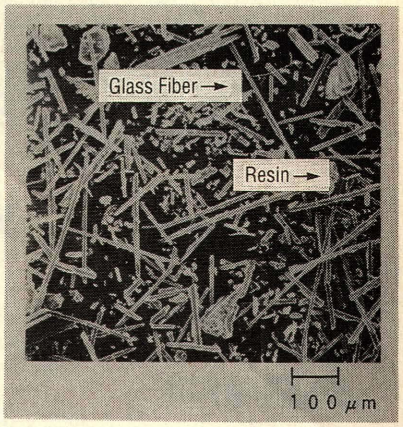
WHAT'S NEWS

continued from page 4

formance under realistic operating conditions and not just in a carefully controlled laboratory environment.

Printed circuit board recycling

NEC Corporation has developed a method for recycling printed circuit board wastes in which PCB mold residue is pulverized and separated into copper-rich powder and powder consisting of glass fiber and resin. Together with IHI Corporation and Nippon Trading Company, Ltd., NEC has found an application for the recovered glass fiber and resin powder as a high-quality filler for resin-based coating material. The recycled material outperforms conventional coating materials such as talc and carbonic acid calcium, offering double the tensile strength and half the thermal expansion rate.


Glass Fiber →
Resin →
100 μm

NEC'S RECYCLING METHOD for printed circuit board wastes separates the copper from the glass fibers and resin.

In the past, most PCB wastes have ended up in landfills. It has been difficult to recycle PCB wastes because of the complex construction of the material. It includes copper in layered circuit patterns, which is hard to pulverize, and epoxy resin that is impossible to remelt. NEC's approach adopts a crushing process and a fine-pulverizing process. Each component of the PCB is selectively pulverized and gravitationally separated. Ω

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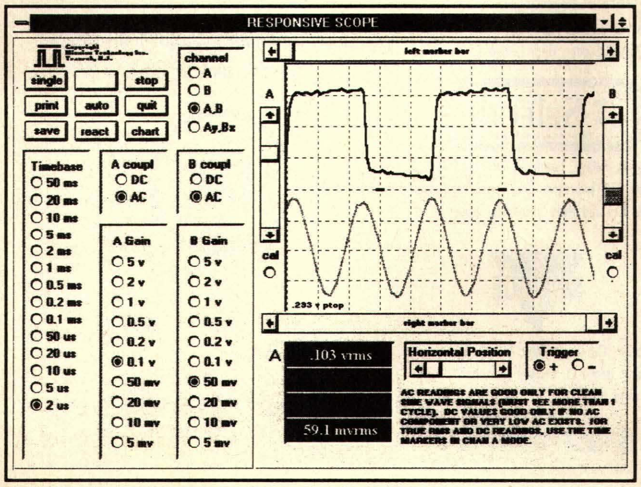
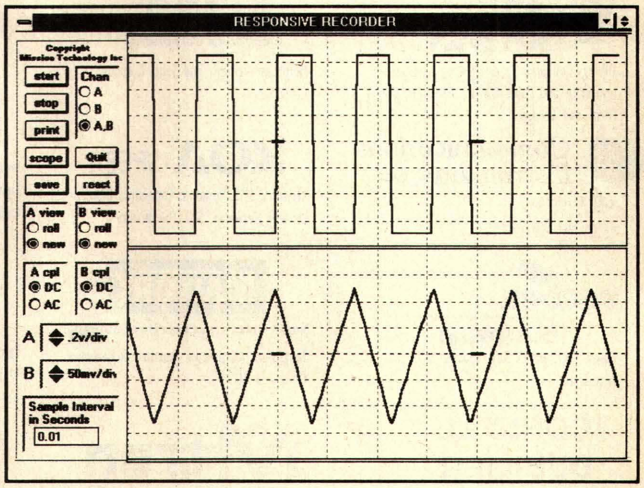
- Easy installation / Auto port detect.
- Made in USA

RESPONSIVE OSCILLOSCOPE
mission technology
CHAN B
CHAN A
OUTPUT


RESPONSIVE SCOPE
single
stop
print
auto
quit
save
react
chart
channel
○ A
○ B
● A,B
○ Ay,Bx
Timebase
○ 50 ms
○ 20 ms
○ 10 ms
○ 5 ms
○ 2 ms
○ 1 ms
○ 0.5 ms
○ 0.2 ms
○ 0.1 ms
○ 50 us
○ 20 us
○ 10 us
○ 5 us
● 2 us
A coupl
○ DC
● AC
B coupl
○ DC
● AC
A Gain
○ 5 v
○ 2 v
○ 1 v
○ 0.5 v
○ 0.2 v
● 0.1 v
○ 50 mv
○ 20 mv
○ 10 mv
○ 5 mv
B Gain
○ 5 v
○ 2 v
○ 1 v
○ 0.5 v
○ 0.2 v
○ 0.1 v
● 50 mv
○ 20 mv
○ 10 mv
○ 5 mv
left marker bar
right marker bar
A
B
cal
.233 t ptop
.103 vrms
59.1 mvrms
Horizontal Position
Trigger
●+ ○-

AC READINGS ARE GOOD ONLY FOR CLEAN SINE WAVE SIGNALS (MUST SEE MORE THAN 1 CYCLE). DC VALUES GOOD ONLY IF NO AC COMPONENT OR VERY LOW AC EXISTS. FOR TRUE RMS AND DC READINGS, USE THE TIME MARKERS IN CHAN A MODE.

Actual scope screen for signals greater than 100 KHz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Copyright Mission Technology Inc
start
stop
print
scope
Quit
save
react
Chan
○ A
○ B
● A,B
A view
○ roll
● new
B view
○ roll
● new
A cpl
● DC
○ AC
B cpl
● DC
○ AC
A .2v/div
B 50mv/div
Sample Interval in Seconds
0.01

Actual recorder screen for slow signals

CIRCLE 183 ON FREE INFORMATION CARD

What Do These Prestigious Companies Have In Common?

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Leadership in electronics is not just a matter of designing products better and manufacturing them better, but also of marketing them better. And the sponsors of this message understand that better service to customers requires effectively involving distributors as part of their marketing teams.

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Getting Connected to the Internet

The Internet is growing at an phenominal rate. Isn't it time you got connected?

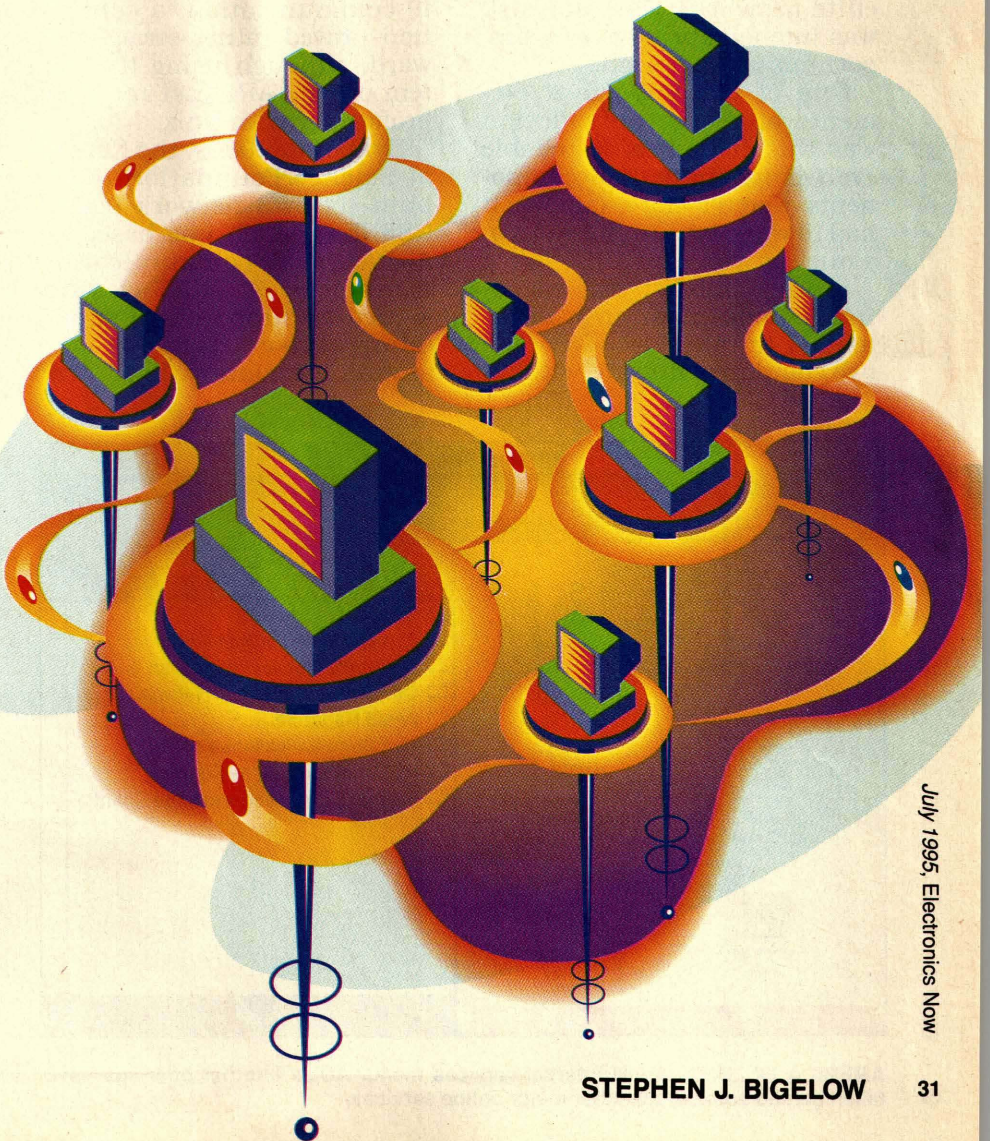
STEPHEN J. BIGELOW

THE INTERNET, LITTLE MORE THAN an academic network only a few years ago, is quickly becoming a global information resource for both companies and individuals. With the explosive growth of Internet service providers and bundled packages of software and documentation, getting online is now faster and easier than ever before. This article takes you inside of the Internet, shows you how to go online, and explains the tools you need to take full advantage of what the Internet has to offer.

The Internet began as a government networking experiment in the late 1960s and has quickly evolved into a complex series of networks that extends around the world. With thousands of university, government, and private industry networks already joined together, the Internet represents an unprecedented information resource for individual computer users and businesses of all sizes. According to The Internet Society, there are already 30 million or more active Internet users—a number that is swelling by 160,000 users each month.

What is the Internet?

Expressed simply—perhaps over simplified—the Internet is nothing more than a network of networks. The individual networks that make up the Internet are owned and operated by their particular university or research center, so no one really "owns" the Internet. There is no centralized authority or administration as there is with commercial online services such as CompuServe or America



Online. Each network is totally independent.

This independence is the main reason why the Internet is so unregulated and why individual users and ordinary businesses have had so much trouble getting connected until recently. It's also the reason why the Internet can be so overwhelming to new users. The Internet offers access to thousands of networks, but unless you know what you are looking for and where it is located, you'll never find it unless you stumble upon it. New users often feel as if they're afloat on a sea of information without a compass.

The Internet had its start in the early 1970s, when the US Defense Department wanted to build a computer network that would link its network, called ARPAnet, to other radio and satellite networks. The network was intended primarily to support military research.

One of the important elements of the network design was that it had to be reliable even if its individual components weren't—for example, it had to work even in the event of a nuclear war.

Since reliability was essential, communication was intended to take place between two computers directly, without regard to the path between them. Any portion of the network could be disabled, and communication would assume one of several alternative paths to the destination. The message being sent was enclosed in a standardized "envelope" known as an internet-protocol (IP) packet. Each IP packet contained the "address" of the destination machine.

The ARPAnet project continued into the early 1980s along with the development of local-area networks (LANs). Most LAN workstations in the early 1980s ran the Unix operating system which had IP networking built-in. Organizations with their own LANs preferred to connect to the ARPAnet rather than a single timesharing computer at their own location. Since Unix supported IP communication, a connection proved rather straightforward, although using the system on the ARPAnet required proficiency with Unix.

By the late 1980s, the National Science Foundation (NSF) built its own network (called NSFNET) which was based on ARPAnet's IP communication technology. NSFNET was designed to support five supercomputer centers located around the country. The intent was to make supercomputing resources—which previously had been available to only a few— available for university research.

All five supercomputer centers needed to be connected together, and all of the universities had to be connected to the centers as well. It would have been prohibitively expensive to connect each university to the NSFNET directly because of the cost of the required dedicated telephone lines. Instead, the NSF created regional networks which allowed each site to be connected in a daisy chain fashion, as well as allow connections for local clients. Thus, messages could be exchanged from computer to computer by passing messages back and forth along the daisy chain. This architecture was the forerunner of what we know as the Internet.

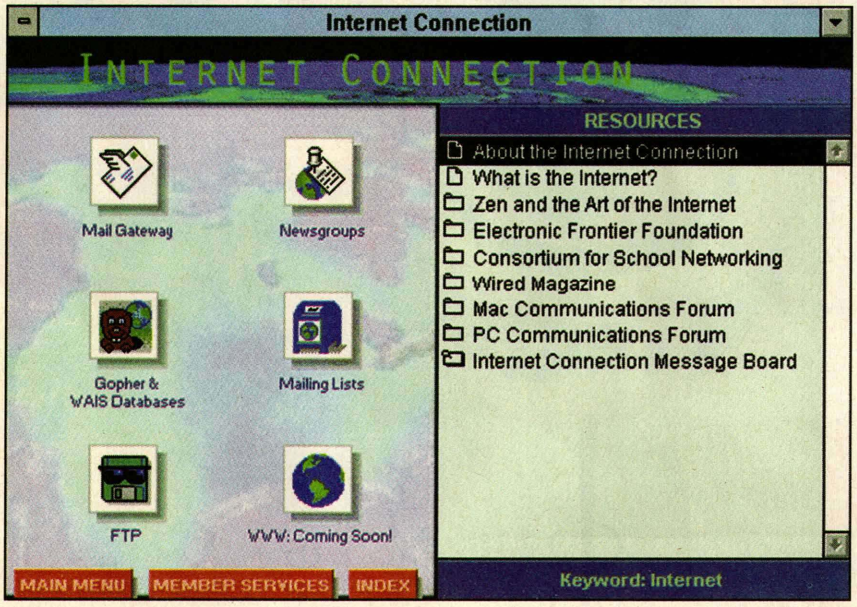
By the late 1980s, the NSFNET became overloaded. Merit Network, Inc. upgraded the NSF network and opened access to academic researchers, government organizations, and contractors. Access was also extended to other countries allied to the United States.

Today, the network built by the NSF forms the backbone of the Internet. But that backbone is joined by over 5000 regional, state, campus, and corporate networks. Links to Canada, Europe, Japan, Australia, Central America, and South America are now operational.

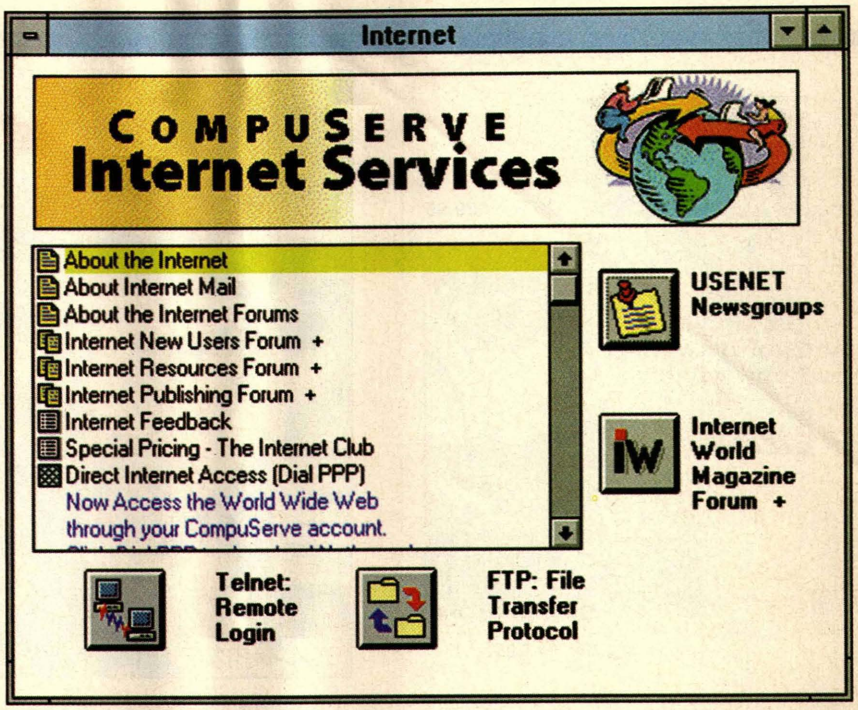
Like all government works, use of the Internet for "personal gain" has largely been prohibited. However, commercial organizations see the Internet as a very viable outlet for selling goods and services. By 1992, restrictions on the commercial use of the Internet were revoked. Today, there are actually more commercial sites using the Internet than educational and research organizations. That trend will almost certainly continue as more users and businesses come online.

Why use the Internet?

The size and scope of the Internet is truly impressive, but what's in it for you? The Inter-



AMERICA ONLINE'S MAIN Internet-services menu. AOL's Internet offerings have fallen behind some of the other major online services.


Internet
CompuServe
Internet Services
About the Internet
About Internet Mail
About the Internet Forums
Internet New Users Forum +
Internet Resources Forum +
Internet Publishing Forum +
Internet Feedback
Special Pricing - The Internet Club
Direct Internet Access (Dial PPP)
Now Access the World Wide Web
through your CompuServe account.
USENET Newsgroups
iW
Internet World Magazine Forum +
Telnet: Remote Login
FTP: File Transfer Protocol

COMPUSERVE'S INTERNET ACCESS menu. Compuserve is becoming more aggressive in its Internet services.

net's resources are staggering but, unless you have a specific need, there is a great deal of information that you will probably never use. However, there are four compelling activities that virtually any reader of *Electronics Now* can benefit from: E-mail, Usenet news, file transfers, and information browsing.

E-mail. Electronic mail or E-mail allows you to exchange messages with anyone on the Internet. That includes any system with an Internet gateway, such as CompuServe, America Online, and even many computer bulletin-board systems (BBS). E-mail is typically much faster—and generally much cheaper—than traditional mail.

Many manufacturers are starting to use the Internet as the forum of choice for national and international tech-support. As a result, your product questions and problems can typically be answered with less frustration from "time-on-hold" on a telephone call. There is little doubt that "live" tech-support is fading fast as manufacturers try to reduce their load of clogged telephone lines.

Usenet newsgroups. There is an incredible variety of electronic discussion groups (or Usenet news groups) available on the Internet. Topics range from the mundane to the bizarre. By "subscribing" to each news group of interest, you can stay in touch with the very latest discussions, opinions, and happenings.

An alternative to the news group is the mail list which echoes copies of pertinent E-mail to all members of the particular list(s). This allows you to keep abreast of the latest news and information in areas that interest you. Like news groups, there are a wide variety of mail lists available on the Internet.

File transfer There is a multitude of files and utilities available on the Internet in the form of shareware and freeware. Using file transfer protocol (FTP) utilities, you are able to retrieve or upload files from a computer in Tokyo as easily as you could from a computer in the next room or down the street—it really doesn't matter where the other computer is located.

Information. As an Internet user, you will find everything from weather reports and space photographs to government databases. Traditionally, the problem has been knowing what's available and knowing where to find it. There are few accurate guides to Internet resources—there is simply too much change and growth.

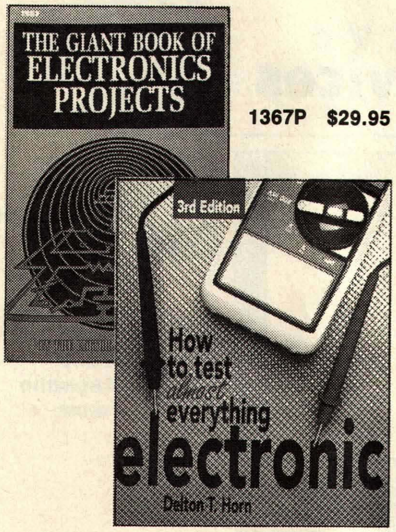
Fortunately, there are a growing number of utilities that make it possible to navigate easily through Internet resources in order to find what is available. Browsing tools allow you to traverse from system to system and review their offerings in a matter of moments.

How to Connect

Connecting to the Internet has always been somewhat of a chore. This was due in part to the lack of central authority, and in part to the lack of personal computers powerful enough to interact with the Internet effectively. Only a few years ago, getting an Internet account was a matter of who you knew. It typically required a mainframe and network at a university or research organization before an Internet connection could be established. Then, individual accounts were distributed as needed to students, educators, researchers - whoever had a good reason to be online.

Even as PCs and operating systems became powerful enough to "stand alone" on Internet, the problem was where to connect. This later problem has largely been resolved by the growth of local Internet service providers who have their networks connected to the Internet, and sell access on their networks to individuals, businesses, and other networks.

You can't simply splice a cable and wind up with Internet access. An Internet service provider therefore becomes a valuable friend and ally. Remember that the Internet is not centrally managed, so there is no one place you can go to sign up. A service provider is a company which owns and operates a network which has assess to the Internet. In turn, the service provider can supply you with several types of connections. The service provider charges you a fee for your connection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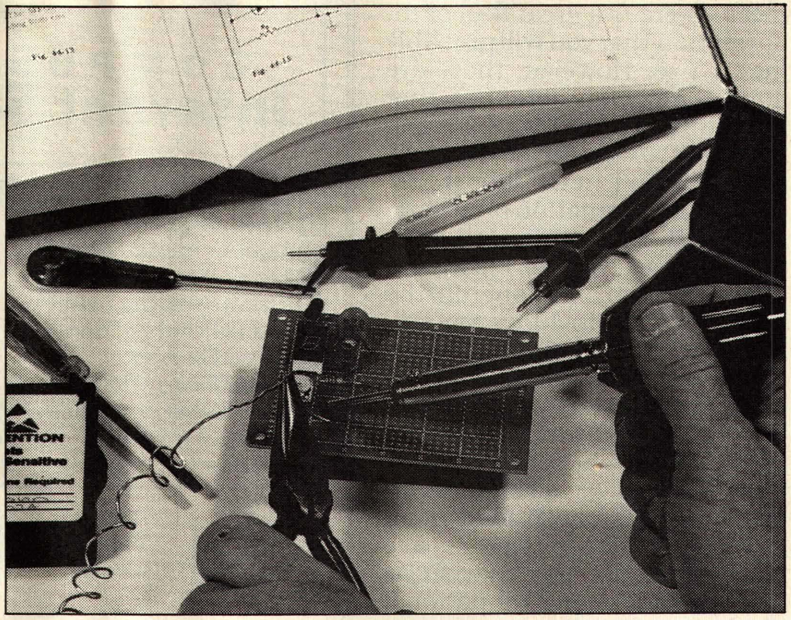

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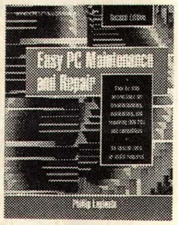
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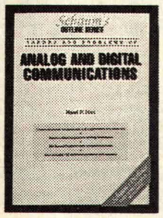
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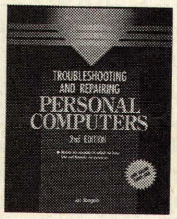
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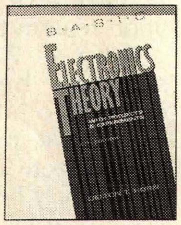
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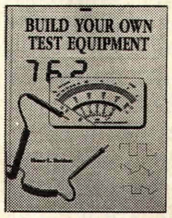
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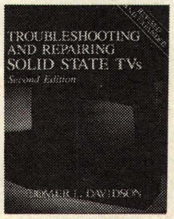
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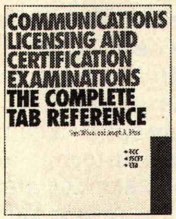
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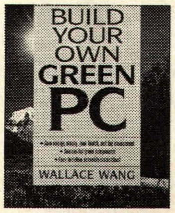
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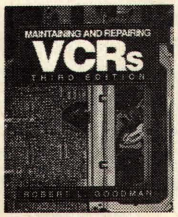
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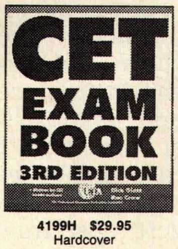
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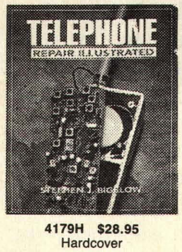
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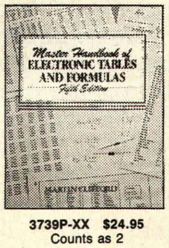
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(telephone line charges are separate), and a portion of those proceeds go to support the Internet as a whole.

It is important for you to remember that not all service providers are created equal. The quality, cost, and reliability of their services can vary radically between providers. Some service providers offer regional coverage, while others offer national support. Many provide service for only a local area. Since all providers are owned and managed independently, any individual provider might not suit your needs. Some are simply better than others.

Your best course is to shop around and compare the deals offered by each provider. Although some people feel more secure with a large, established national service provider, others like the cost benefits and customer service that local providers are known for.

Today, a service provider can offer three typical paths to the Internet; the direct connection, the dial-in connection, and the online service. Each path carries its share of requirements and costs, so consider your needs before proceeding.

Direct connection. A direct connection is clearly the most powerful and expensive form of Internet connection. In effect, you must have (or be part of) a network. You will then need a dedicated telephone line such as a 56 kilobit per second (kbps) line, or a T1 (1.5 megabits per second) line. You'll also need special hardware and software (typically purchased or leased from your service provider) to support your connection to the service provider.

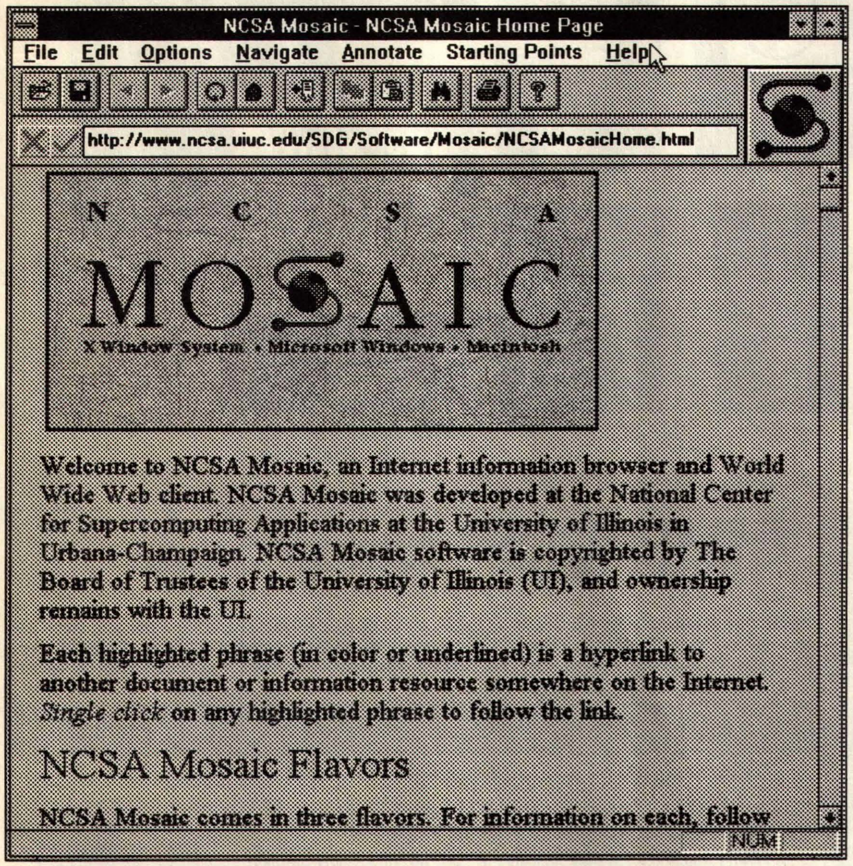
A direct connection offers some distinct advantages. For example, you can set up an FTP server which allows outside individuals and organizations to access your systems. In effect, you become a tangible new part of the Internet. Commercial organizations moving to do business on the Internet often take advantage of that capability. Next, a direct connection keeps you permanently online. And third, at 56 kbps or faster, file transfers will be accomplished much faster than with a standard dial-up line.

Unfortunately, the direct connection carries a substantial cost. A dedicated connection can easily cost an organization $15,000 to $20,000 or more in the first year, and a bit less each subsequent year. A direct connection is reserved for organizations which need and can afford them.

Dial-in connection. As an alternative to direct connections, most service providers offer dial-in (or dial-up) connections. The dial-in connection is a medium-performance connection which requires only a PC and a modem. In general, the faster the modem, the better. The dial-in account works much like other standard online services: you dial a number to your service provider, establish a modem connection, and enjoy your Internet access.

The dial-in connection can offer varying degrees of access. Many providers offer a Unix shell account, which might give menu access to E-mail and newsgroups. Others might provide FTP and Telnet capability.

Another kind of dial-in connection is the SLIP or PPP account, which requires that you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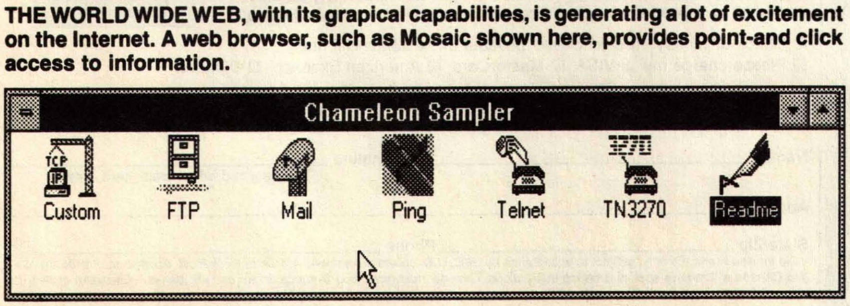
Welcome to NCSA Mosaic, an Internet information browser and World Wide Web client. NCSA Mosaic was developed at the National Center for Supercomputing Applications at the University of Illinois in Urbana-Champaign. NCSA Mosaic software is copyrighted by The Board of Trustees of the University of Illinois (UI), and ownership remains with the UI.

Each highlighted phrase (in color or underlined) is a hyperlink to another document or information resource somewhere on the Internet. *Single click* on any highlighted phrase to follow the link.

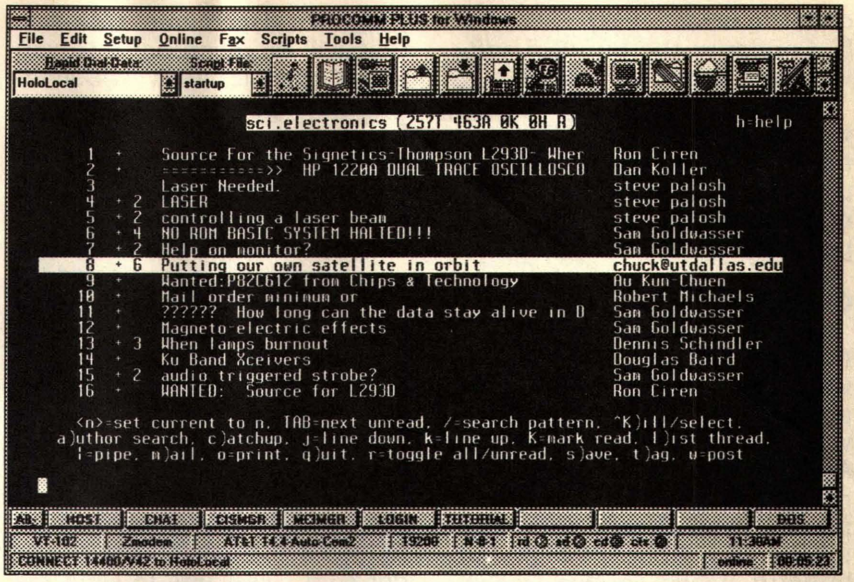
NCSA Mosaic Flavors

NCSA Mosaic comes in three flavors. For information on each, follow

THE WORLD WIDE WEB, with its grapical capabilities, is generating a lot of excitement on the Internet. A web browser, such as Mosaic shown here, provides point-and click access to information.



THE CHAMELION SAMPLER packaged with the Internet Membership Kit contains the most important applications you'll need online.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A GRAPHICAL INTERFACE is not required to get what's really important—information—from the internet.

run software and TCP/IP drivers on your PC to match the connection type.

SLIP and PPP connections provide virtually all of the capabilities that a direct connection would, because, in essence, the connection puts your computer directly on the Internet. (With a Unix shell account, your computer is acting as a terminal of a computer that is on the Internet.) With a SLIP or PPP account, your connection is active only while the modem connection is established. Thus, the cost is only a per-hour connect fee (usually under $100 for 80 hours/month of service). If you are making a toll call for access, you can expect to pay a toll fee as well. Even with toll charges, a dial-in connection is the preferred type of Internet access for individuals and many small-businesses.

Most service providers can easily support SLIP accounts, and much of the bundled software out there is written for SLIP operation. PPP is a slightly newer and more effective protocol, but fewer service providers support it, and less of the available software is designed to take advantage of it.

Dial-in connections are greatly simplified by the trend toward "bundling" Internet access software and TCP/IP drivers with reference books. There are a number of good starter bundles out there; the one discussed here is the *Internet Membership Kit* from Ventana Press. Although its Chameleon Sampler software was not the simplest software to configure, it has everything needed to go online.

Even if you choose to buy a different bundle, the requirements and the process is generally the same. The PC itself should be based on a 386 or faster CPU, and it should have four megabytes or more of RAM, DOS 5.0 or later, Windows 3.1 or later, and at least 10MB of available hard drive space.

The steps to getting connected are:

1) Install the bundled software under Windows.

2) Choose a service provider—publishers that bundle books and software generally strike excellent deals with national service providers.

3) Call the chosen provider by phone or BBS to establish the account.

4) Wait a day or two for the ac-

INTERNET GLOSSARY

Archie—A system used for locating files stored on FTP servers.

Backbone—The main supporting network infrastructure which composes the Internet.

Finger—A software feature used to determine if another particular user is logged onto the Internet, and can be used to find E-mail addresses.

FTP (File Transfer Protocol)—A protocol that describes the transfer of files between a host and remote computer.

Gopher—An Internet search tool (a "browser") that presents information as a hierarchy of menus or table of contents.

IP (Internet Protocol)—A standard protocol that describes how packets of data are transported across the Internet and interpreted as a message.

News group—A forum or conference area (similar to a BBS or other online service) where you can post messages on a specific topic.

NNTP (Network News Transport Protocol)—An extension of TCP/IP which describes how news group messages are transported between various compatible servers.

PING (Packet Internet Gopher)—A TCP/IP utility that simply sends packets of information to another computer on the Internet - this can be used to determine if a certain computer is connected.

Protocol—A set of rules or standards that describe operational characteristics.

Router—A combination of hardware and software that directs messages between LANs.

SLIP/PPP (Serial Line IP/Point-to-Point Protocol)—Two popular protocols that allow dial-in access to the Internet through a serial (modem) link.

SMTP (Simple Mail Transfer Protocol)—The TCP/IP protocol that defines how E-mail moves between host and user systems.

TCP/IP (Transmission Control Protocol/Internet Protocol)—A complete combination of network and transport protocols that allow a PC to interact with other PCs or networks on the Internet.

Telnet—A terminal emulation program that allows you to access other computers on the Internet in an interactive fashion.

Usenet—The full complement of news groups available on the Internet.

Veronica—A browsing tool (similar to Archie or Gohper) that searches the text appearing in Gopher menus.

WAIS (Wide Area Information Server)—Software to index large text files. It also finds and retrieves documents based on user-defined keywords.

WHIOS—A TCP/IP utility that allows you query various servers about other Internet users.

Winsock (Windows Socket)—A Windows API that lets Windows applications run on a TCP/IP network.

WWW (World-Wide Web)—A network of servers using hypertext links to find and access files - many servers offer sound and video support.

count to be activated.

5) Configure the bundled software and start your access.

Once you are finally online, you can download (or "FTP") additional shareware or freeware utilities which offer even better mail, news, or browsing capabilities.

Online services

Of course, there are quite a few readers who don't need or want all of the services offered on the Internet. An online service such as CompuServe, America Online, or Delphi already serves most of their needs. If you already subscribe to an online service or high-end bulletin board service (BBS), you also have limited access to the Internet—the number and quality of the services that are offered depend on the particular service, and the price varies as well. Contact the customer service department of your preferred online service for a breakdown of their available Internet services.

Addressing and naming

Of all the subtle complexities of the Internet, few evoke more frustration and confusion among new users than naming conventions. On the surface, that collection of numbers and nonsense words may seem arcane or even random. But there is a method to the madness.

Each computer connected to the Internet has two addresses; an IP address, and a domain name. The IP address is a series of four numbers (each less than 256) which are separated by periods. For example, a typical IP address might look like; 134.84.101.1. For the most part, you do not have to concern yourself with remembering IP addresses—just the domain name.

There are actually several types of names involved in the naming process; the user name, the domain name, and the top domain name. The user name is the alphanumeric string that identifies you as an individual. A user name can be completely arcane (such as axcl3ex), but if you are in a position to choose your own user name, pick one that will be meaningful to you and the people who will be sending you E-mail. For example, my user name, sbigelow, is based on my real name.

The domain name generally refers to the supporting network (or service provider) that your computer is connected to, and is separated into two parts; the domain name itself, followed by a three-character top domain name. For my account, the domain name would be cerfnet, and the top domain would be com. Taken together, my Internet name is sbigelow@cerfnet.com - pronounced "s-bigelow at surf-net dot com." Feel free to send me some E-mail when you get online.

Of course, the names mentioned so far are pretty simple. What happens with a address like: j—jones@rabbit.oit.unc.edu? Well, reading the address gets a bit more complicated, but the basic rules are the same. First, the user name (j—jones) is easy enough to find. The term right after the @ symbol is the computer's name (rabbit), and the top domain name (edu) identifies the address as an educational institution. The string "oit" represents Office of Information and Technology, while the string "unc" indicates the University of North Carolina. Unfortunately, you might not know that by simply looking at the symbols. What this means for you is that not all addresses are self-explanatory.

You can tell a bit about the type of domain from looking at the top domain name. The three character code explains what type of organization the domain represents. There are six top domain names that are generally used in the United States:

com—a commercial business or organization
edu—an educational institution such as a college or university
gov—a government department or organization
mil—a military installation or organization
net—network resources - an integral part of the Internet infrastructure
org—typically a non-profit or other organization

For users outside of the US, the top domain name is a two character country code. Such geographic addressing is also used in the U.S., in which case an address might look something like: user@well.sf.ca.us.

Tools of the trade

Once you are finally online with a dedicated or dial-in connection, you will be faced with the challenges of exploring the Internet. Over the years, a variety of tools have developed to serve each individual function. Let's assume that you're an individual user who has purchased bundled software and documentation.

The tools that come with your bundled software are certainly useful and functional, but few packages contain the full-blown versions of those tools. This means that while you'll be able to perform a variety of functions, you probably can not take full advantage of the Internet. At the very least, a bundled software package will offer five working areas;

The TCP/IP stack. This is a vital background utility which allows your Windows PC to communicate with your service provider through standard TCP/IP. The TCP/IP stack is typically loaded before dialing your service provider, and unloads after the connection is severed. Without this function, your individual dial-in connection would not work.

E-mail utility. Virtually all bundled Internet software offers an E-mail utility which allows you to retrieve and create your own E-mail. Mail utilities vary in quality and efficiency, but they get the job done.

FTP utility. Part of the power of the Internet is your ability to get into other computers around the world to upload or download files. Software bundles typically provide a basic FTP utility. Using FTP, you can download articles, electronic books, and other more powerful Internet utilities.

Continued on page 88

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THE VIDEO REVOLUTION IS IN FULL swing, capturing the world in sound and action. The still camera has been capturing treasured moments for more than a century. Both cross paths in this video inverter project which lets you view positive, color-corrected photographic images on a video monitor.

Have you ever held a color negative up to a light and tried to view it? It's difficult to identify the picture, let alone judge its photographic merit. But if you use the macro setting on your camcorder to focus on a back-lit photographic negative, the video inverter presented here will let you see a positive, color-corrected image on a TV screen or video monitor. Illumination is provided by a small commercially available light box or you can improvise one with a fluorescent bulb. A set of inexpensive plastic filters between the light source and the negative let you maintain color balance for various film types, lighting conditions, and personal taste.

The video inverter lets you run your own mini photo lab. You can look at your negatives on-screen and crop them to obtain the best composition. A TV screen will show you how an actual enlargement might look. You can experiment with exposure and color balance to fine-tune the mood of the picture. You can also record your favorite still shots on videotape for easy group viewing.

The video inverter can also save you money. Say, for example, that you return from vacation with five rolls of film to be developed. At $5 to $15 per roll for standard prints, your bill could add up to as much as $75. But if you have a video inverter and a camcorder, just tell the photo lab that all you need is developed negatives, which should cost only about $15 for all five rolls. Then you can view the negatives on a TV screen and choose only the shots you want to be printed by the photo lab—or make a video tape of them and forget about the prints! If you have your own darkroom, you can use the video inverter to preview color or black and white negatives before printing.

How it works

As you probably already know, a photographic negative is dark where the resulting print will be light and, conversely, the negative is light where the print will be dark. This is very straightforward for black-and-white negatives, but a little bit more complicated for color negatives. The principle of opposite color values is used to impress color on negative film. If you place red, magenta, blue, cyan, green, and yellow at equidistant points on a circle as shown in Fig. 1, the color on a negative will be exactly opposite that of the color print on the color wheel. For example, a red rose appears cyan (blue-green) on the negative, a yellow rain jacket appears blue, and green grass appears magenta (purple).

Another characteristic of a color negative is that the photographic emulsion is suspended on a brown plastic film. The brown hue varies from orangy-brick to purplish or gray-green, depending on the manufacturer of the film. To recreate the original positive image from a negative, as is done routinely in the photographic print making process, one must invert light and dark, exchange each color value for the opposite value, and neutralize the brown hue of the negative.

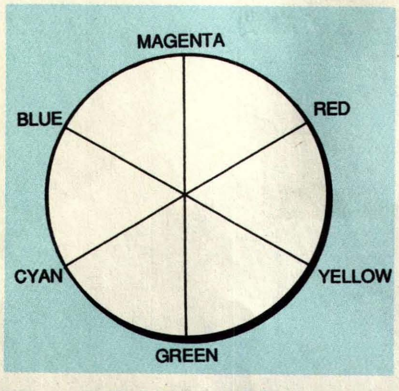

MAGENTA
RED
YELLOW
GREEN
CYAN
BLUE

FIG. 1—THIS COLOR CIRCLE, or color wheel, shows the different colors that are the opposites.

The video signal

The NTSC RS-170 video signal carries luminance and chrominance information along with synchronization signals. The luminance part of the video signal carries information about the light and dark areas of the picture. The chrominance part—3.58 MHz color subcarriers—carries hue information and color saturation information. The hue is determined by the subcarrier's amplitude, and the saturation is determined by its phase. The vertical- and horizontal-sync pulses mark the beginning of each picture frame and each line, respectively.

The colorburst contains eight cycles of a 3.58-MHz sinewave that acts as a reference to allow demodulation of the chrominance signal. The phase difference between the chrominance signal and the colorburst determines the hue.

The circuit inverts the luminance and chrominance signals in the NTSC output from a camcorder, as shown in Fig. 2. How-

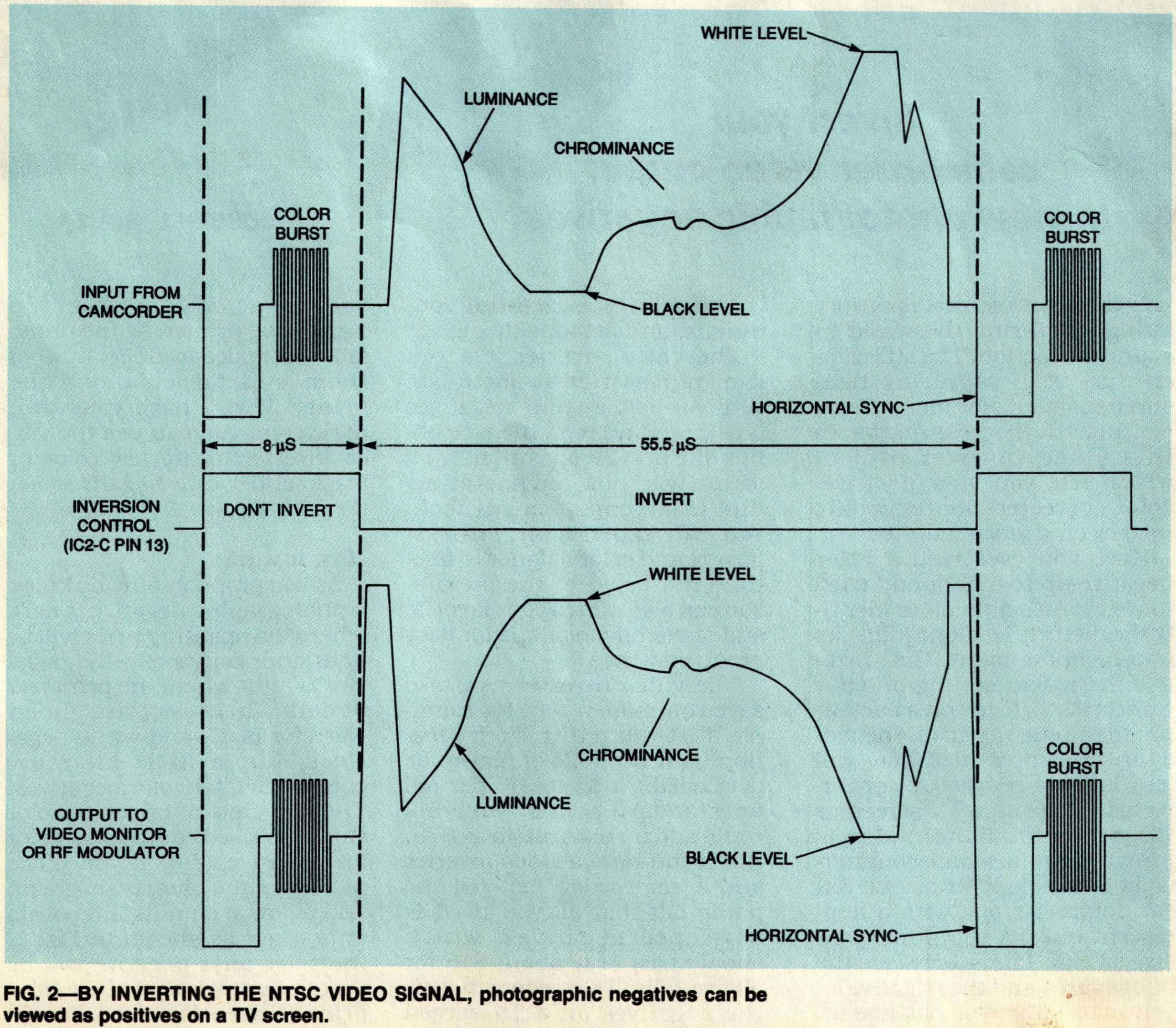

WHITE LEVEL
LUMINANCE
CHROMINANCE
COLOR BURST
INPUT FROM CAMCORDER
BLACK LEVEL
COLOR BURST
HORIZONTAL SYNC
8 µS
55.5 µS
INVERSION CONTROL (IC2-C PIN 13)
DON'T INVERT
INVERT
WHITE LEVEL
CHROMINANCE
COLOR BURST
LUMINANCE
OUTPUT TO VIDEO MONITOR OR RF MODULATOR
BLACK LEVEL
HORIZONTAL SYNC

FIG. 2—BY INVERTING THE NTSC VIDEO SIGNAL, photographic negatives can be viewed as positives on a TV screen.

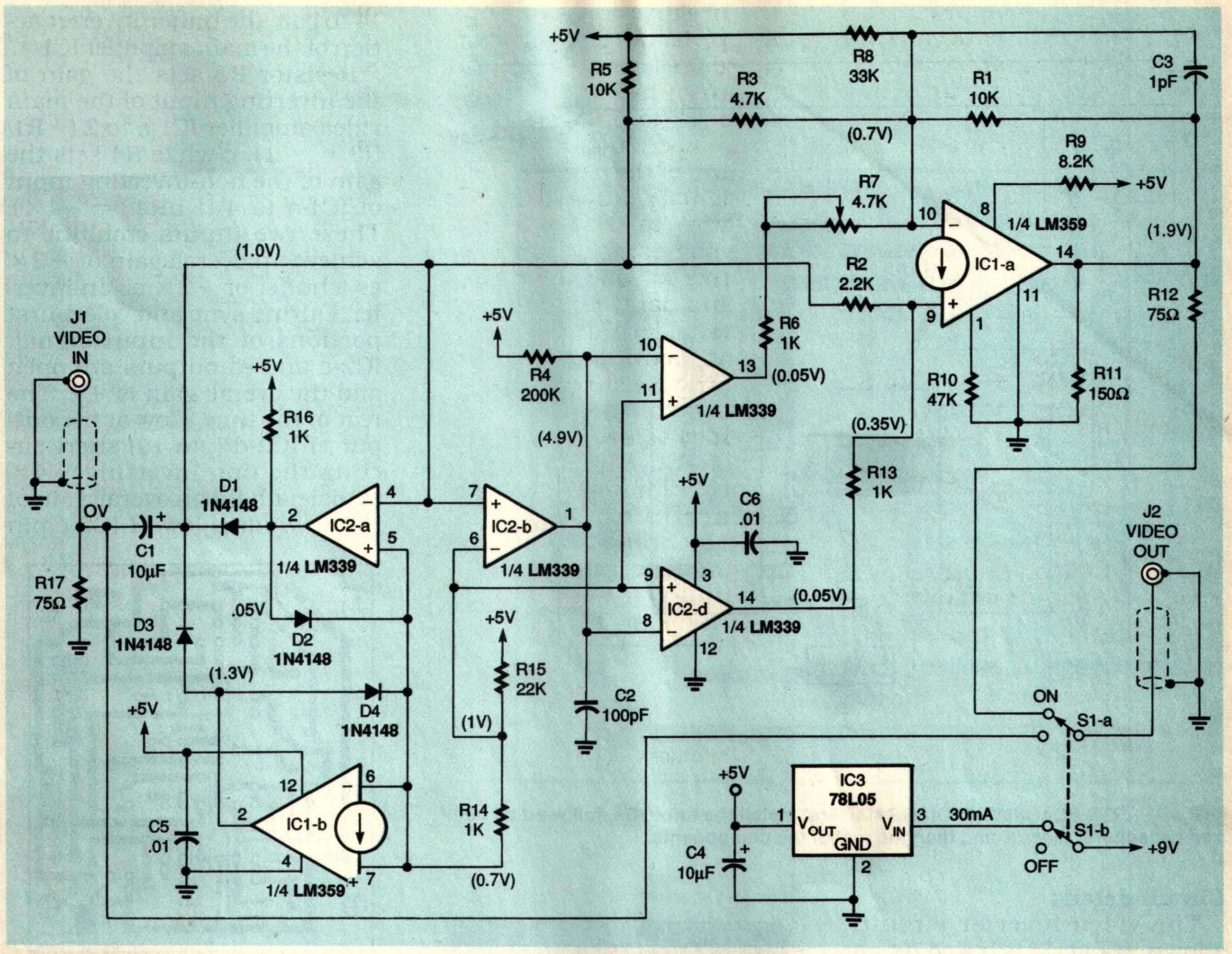

+5V
R5
10K
R3
4.7K
R8
33K
R1
10K
C3
1pF
(0.7V)
R9
8.2K
+5V
R7
4.7K
10
8
1/4 LM359
(1.9V)
(1.0V)
R2
2.2K
IC1-a
14
11
R12
75Ω
9
1
J1
VIDEO
IN
+5V
R6
1K
10
13
(0.05V)
11
1/4 LM339
R4
200K
R10
47K
R11
150Ω
+5V
R16
1K
(4.9V)
(0.35V)
R13
1K
+5V
C6
.01
J2
VIDEO
OUT
D1
1N4148
OV
C1
10µF
2
IC2-a
4
5
1/4 LM339
7
IC2-b
6
1
1/4 LM339
9
3
IC2-d
14
(0.05V)
8
1/4 LM339
12
R17
75Ω
D3
1N4148
.05V
D2
1N4148
+5V
R15
22K
C2
100pF
(1.3V)
D4
1N4148
(1V)
ON
S1-a
+5V
+5V
IC3
78L05
12
6
C5
.01
2
IC1-b
4
1/4 LM359
7
R14
1K
(0.7V)
1
V_{OUT}
GND
V_{IN}
3
30mA
2
C4
10µF
S1-b
OFF
+9V

FIG. 3—SCHEMATIC DIAGRAM OF VIDEO INVERTER. The circuit is based on an LM359 dual Norton op-amp and an LM339 quad voltage comparator.

ever, it leaves the vertical sync, horizontal sync and colorburst uninverted.

A blue *roscolux* plastic filter between the negative and the light source is usually required to neutralize the brown tint in the negative and adjust for proper color balance. However, some video cameras have a manual white-balance control that can achieve good color balance without the filters.

Properly decoding an NTSC video signal without loosing potential image resolution is challenging because the luminance frequency spectrum overlaps and interleaves with the chrominance spectrum. All of the video inverter's processing is done without splitting the luminance and chrominance into separate signals to avoid any loss of resolution. The blue plastic filters eliminate the need to demodulate and potentially degrade the NTSC video signal.

PARTS LIST

All resistors are ⅛-watt, 5%
R1, R5—10,000 ohms
R2—2200 ohms
R3—4700 ohms
R4—220,000 ohms
R6, R13, R14, R16—1000 ohms
R7—4700 ohms, trimmer potentiometer
R8—33,000 ohms
R9—8200 ohms
R10—47,000 ohms
R11—150 ohms
R12, R17—75 ohms
R15—22,000 ohms

Capacitors
C1, C4—10 µF, electrolytic
C2—100 pF, ceramic
C3—1 pF, ceramic
C5, C6—0.01 µF, ceramic

Semiconductors
IC1—LM359N Norton op-amp (National Semiconductor or equiv.)
IC2—LM339N quad comparator (National Semiconductor or equiv.)
IC3—78L05 5-volt regulator
D1–D4—1N4148 switching diode

Other components
S1—DPDT miniature toggle switch
J1, J2—male/female RCA jacks and shielded cable (see text)

Miscellaneous: Case (Radio Shack 270-293), 9-volt battery clip, 9-volt battery or battery eliminator (Radio Shack 273-1552), mini light box (Letraset Mini-Pro), Roscolux plastic filters (Edmund Scientific N39,417), PC board, wire, solder

ORDERING INFORMATION

- **A single-sided PC board is available for $15.00 from Joseph L. Sousa, 38 Cornish St., Lawrence, MA 01841-1226. Check or money order, only.**
- **A Letraset Mini-Pro light box is Available from Charette, 31 Olympia Ave., Woburn, MA 01888, 617-935-6000**
- **A similar, compact light box is available for $19.95 + S&H from Visual Horizons, 181 Metro Park, Rochester, NY 14623-2666, 716-424-5300, Fax 716-424-5313**
- **The Roscolux filters are available from Edmund Scientific Company, 101 E. Gloucester Pike, Barrington, NJ 08007-1380, 609-573-6250**

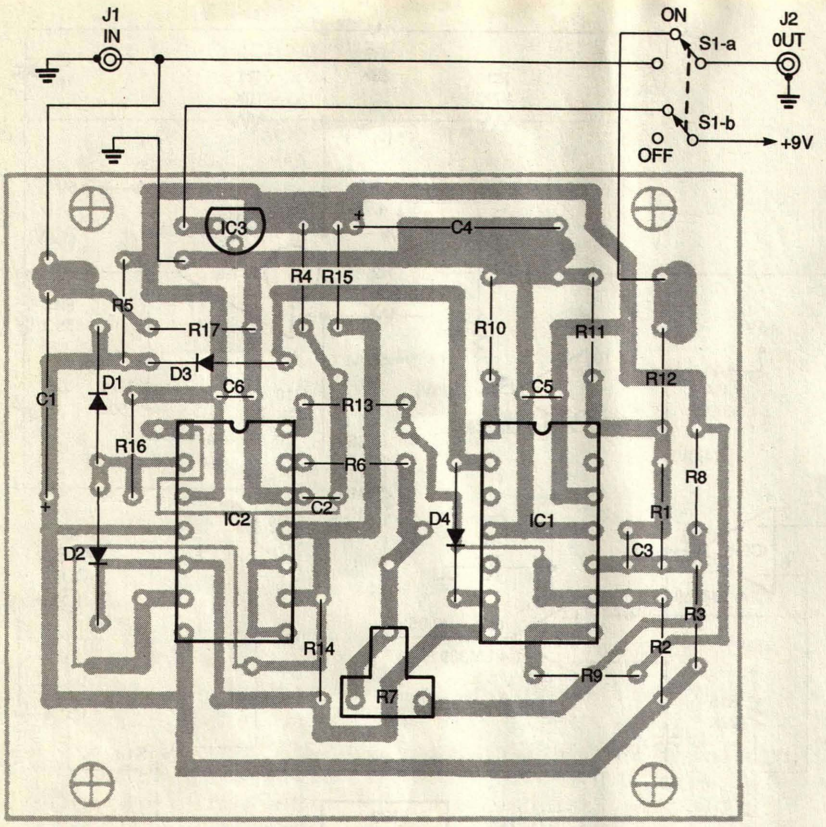


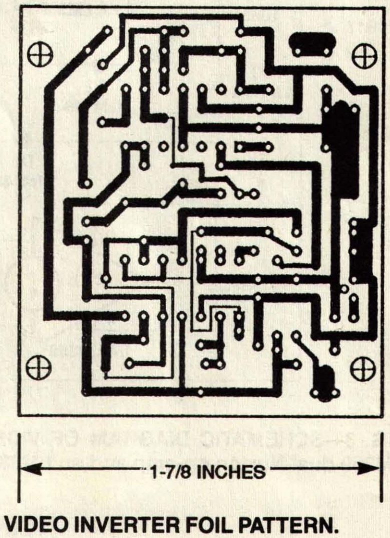
FIG. 4—PARTS-PLACEMENT DIAGRAM. First install the three ICs, followed by polarized capacitors, diodes, and then the rest of the components.

Circuit details

The video inverter circuit, shown in Fig. 3, is based on an LM359 dual Norton op-amp and an LM339 quad voltage comparator. Those two ICs handle DC restoration, sync detection and processing, and buffering and inversion of the video signal. The DC level of the video signal is restored to 0.7 volt because the inputs of IC1-b operate at one diode voltage drop above ground. Diodes D1 and D3 charge the positive side of C1 to keep the bottom of the sync pulses at +0.7 volt, and D2 limits the maximum output of IC2-a at pin 2 to +1 volt.

Comparator IC2-b acts as a threshold detector set to detect sync pulses 300 millivolts above the restored DC level of 0.7 volt. Components C2 and R4 stretch the detected 4-microsecond sync pulses to 8 microseconds to include the duration of 8 cycles of 3.58 MHz color burst after the input sync pulse. Comparators IC2-c and -d buffer the stretched sync pulse with open-collector outputs at pins 13 and 14 to gate the buffer/inverter action of the main amplifier IC1-a.

Resistor R3 sets the gain of the inverting input of the main video amplifier IC1-a to 2 (−R1/R3 = −2×), while R4 sets the gain of the non-inverting input of IC1-a to 4 (R1/R4 = +4×). These two inputs combine to achieve an overall gain of +2× as a buffer or −2× as an inverter. During sync and colorburst portions of the input signal, IC2-c and -d outputs are open and the overall gain is +2. The rest of the time a low at the output of IC2-d (pin 14) short circuits the non inverting +4× signal path for an overall gain of −2×, while a low at IC2-c pin 13 injects the necessary offset in the inverted video signal to keep it above the black level. Potentiometer R7 adjusts the black level at the output to correspond to the peak white level in the negative. Resistor R12 matches the output for 75 ohms.



VIDEO INVERTER FOIL PATTERN.

A 78L05 regulator (IC3) provides a stable 5-volt supply from a 9-volt battery or AC adapter. With a current drain is about 30 milliamperes, a 9-volt alkaline battery should last about 10 hours. The 78L05 will output a steady 5 volts until the battery drops to 7 volts. At that point the image colors will start washing out before the circuit stops working completely. Switch S1 turns power on and off, and also bypasses the input video signal around the video inverter circuit when it's turned off.

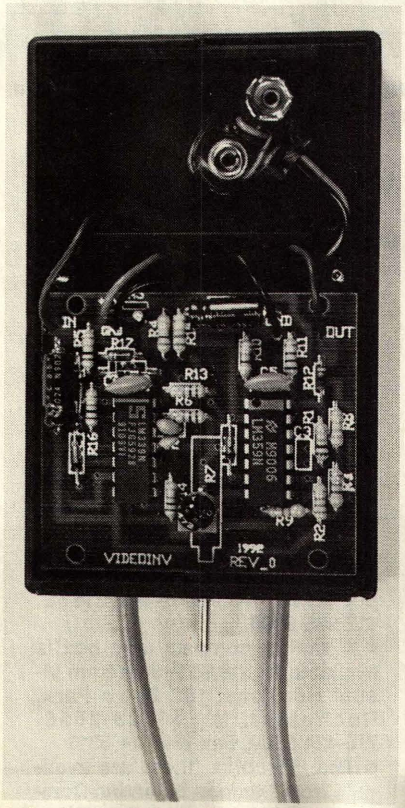


FIG. 5—THE PC BOARD is designed to fit in the specified case without the need for screws.

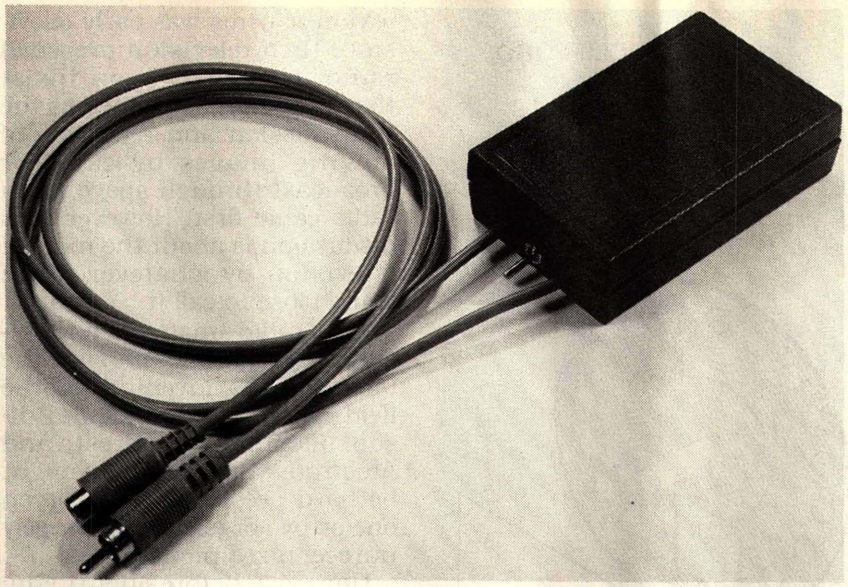


FIG. 6—COMPLETED VIDEO INVERTER. This compact unit connects directly to other video equipment.

Construction

For best performance, build the video inverter on a PC board. A foil pattern is provided here if you want to make your own board, or you can purchase one from the source given in the Parts List. The PC board was designed to fit in a particular case (see Parts List) without the need for screws. The case contains a compartment for a 9-volt battery. You can use the mounting holes on the board if you choose a different case.

Figure 4 is the parts-placement diagram for the PC board. First install the three ICs, followed by polarized capacitors, diodes, and then the rest of the components. Before connecting the cables, inspect the board for solder bridges, especially between the pins of ICs. Installing the 9-volt battery clip lets you use either a 9-volt battery or a 9-volt battery eliminator.

Drill a 3⁄16-inch hole on the front panel for the power switch. Locate the hole ¼-inch from the bottom of the panel so that the switch won't interfere with the PC board. Place a small piece of cardboard between the bottom of the PC board and the cable connections to S1 to avoid short circuits.

Input jack J1 is a male RCA plug connected to the end of a shielded cable. This will connect directly to the video output of a camcorder. The output jack J2 can be either a female RCA jack to connect to a camcorder's RF modulator, or another male RCA jack to connect directly to a video monitor or VCR; either should be connected to the board by a length of shielded cable. A convenient way to simplify wiring the jacks is to buy a ready-made 3-foot patch cord with your choice of jack and plug on each end and cut it in half. Then solder the cut ends to the inverter circuit. You must also drill holes in the case's front panel to pass the input and output cables through. Figure 5 shows the board seated in the case, and Fig. 6 shows the assembly all buttoned up.

Test and adjustment

Before you close-up the case, you must adjust R7 for the proper black level of the inverted video signal. The best way to make this adjustment is to apply power to the video inverter with the input and output cables unconnected, and then adjust R7 for a reading of 1.9 volts at J2. If you don't have a voltmeter, set R7 about midway. Then, once the inverter is connected to a camcorder, finely adjust R7 to make the black parts of the picture look right. The schematic diagram in Fig. 3 shows several DC voltage readings taken with the input and output cables unconnected. You can use them to help troubleshoot the circuit.

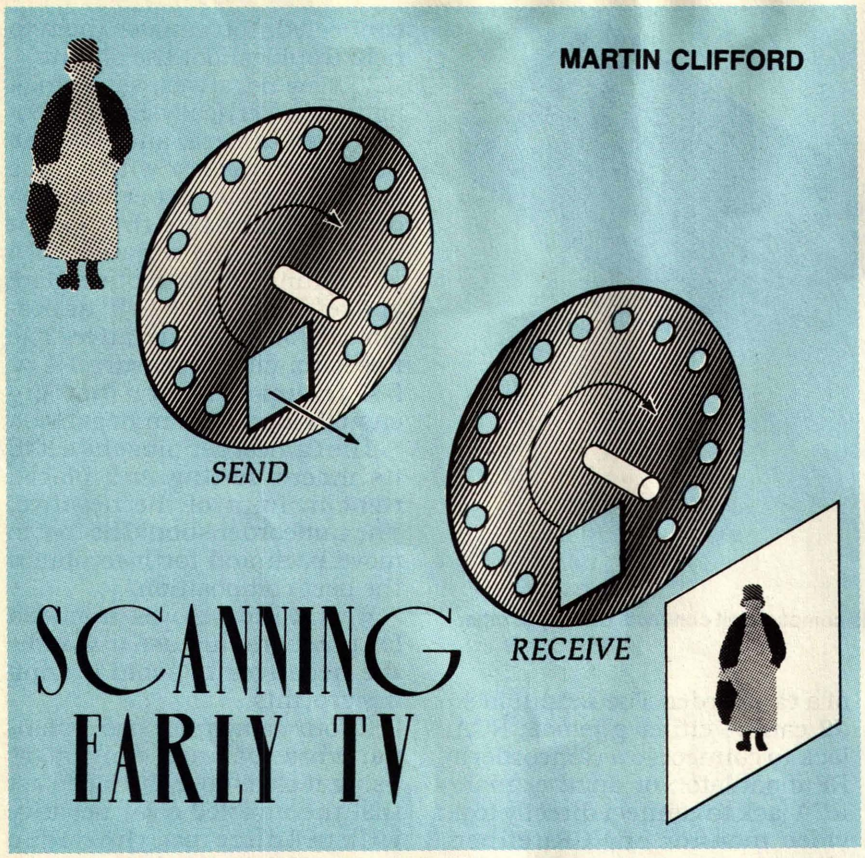
To view negatives, set a small light box vertically in front of the video camera, and hold the negative to the box with a piece of clear acetate. Cover the area over the light box that is not used to view the negative with aluminum foil to reduce glare and reflect as much light as possible through the negative. The Roscolux filters measure 1½ × 3¾ inches and are just big enough for a 35 mm negative.

The camcorder must be set to its macro setting and placed right in front of the negative. The camcorder should be free to move back and forth to obtain the best composition.

Wear cotton gloves intended for photographic use to handle the negatives to avoid leaving fingerprints.

If your camcorder has a manual white balance control try using it to remove the blue cast that the inverted color negative will produce on the video screen. If the white balance control doesn't do a good enough job, use the Roscolux filters. The right filter choice requires some experimentation. If the image is too blue, add a blue filter. If the image is too red, lighten the blue filter. If the greens are weak and the image is too purple, add a purple filter. It seems paradoxical, but if there is too much of one color on the video screen, you must add more of that color to the negative. Use the less saturated, lighter filters, such as the No. 848, No. 849, No. 850, No. 842, No. 804, and No. 825 filters. In various combinations, those Roscolux filters are most useful for viewing negatives from different types of color film.

Set the color, tint, brightness, and contrast controls on the TV or video monitor for normal viewing before using the video inverter. You can tweak them to achieve the best image afterwards. If your TV set decodes the vertical interval reference (VIR) signal that is normally broadcast by networks and TV stations, be sure to turn the VIR switch off while you are using the video inverter. Ω



SCANNING EARLY TV

MARTIN CLIFFORD

The first television systems, cumbersome, short-range contraptions that sent pulses over wires, were more akin to facsimile than modern TV.

TELEVISION, BECAUSE OF ITS RELAtively recent public appearance, is commonly believed to be a younger spinoff of radio. However, its actual beginnings date from the middle of the last century, about the same time that Samuel F. B. Morse invented the telegraph, and this was 30 years before Alexander Graham Bell invented the telephone.

Nearly a century before television became a practical reality in 1923, it was known that sound waves could be transmitted as modulated electric currents in wires and that electromagnetic waves could be transmitted without wires. So it didn't seem too far-fetched for some visionaries to believe that images could somehow be converted into electrical impulses and sent to distant receivers.

Television as it exists today owes an immense debt to many famous inventors as well as many unsung scientists, experimenters, and tinkerers who contributed to the telegraph, the telephone, radio transmission, moving pictures, and vacuum tubes. The technology has been inexorably intertwined.

What most of us consider as modern television was demonstrated successfully before the invention of electronic scanning and the camera and picture tubes, but not before the invention of the radio and cathode-ray tubes. The object to be televised was scanned mechanically, and the received televised image was either viewed directly or projected onto a moving picture screen.

Lost in history

If you are willing to accept that the transmission of still pictures (even crude ones) and text over wires was early television, then television preceded radio. However, if you insist that television be defined as the transmission and reception of moving images by cable or broadcast through space, then radio came first. However, this discussion is about the roots of television by whatever name you choose to call it.

Most radio amateurs, and science history buffs can name the most famous inventors in the field of radio. These include Edison, Fleming, de Forest, and Amstrong. But even they might be hard pressed to name even one or two of television's largely unrecognized pioneers.

However, before identifying some of the television's pioneers, it's worth reviewing the physical and physiological basis for television reception.

Tricking the brain

A fundamental property of the human eye is *persistence*— the ability of the eye to hold onto an image for milliseconds after the image has changed. This effect permits us to see both moving pictures and television. If a series of nearly identical cartoons or pictures that differ only in minor details are flipped rapidly in front of you, the image will appear to move. As the pages snap by, you might perceive an athlete jumping over a hurdle or a horse galloping around a racetrack.

The early television pioneers were aware of this characteristic. They recognized that all picture elements do not have to be transmitted simultaneously. If they are transmitted in a sequence that is rapid enough, the eyes will assemble them into a complete picture. The pioneers knew that persistence of vision permits us to see movies.

For this reason, if all television picture elements are transmitted at the same time, the speed must be fast enough for the eye to retain the impression of the first picture element before the last one arrives. In this way, the illusion of simultaneous transmission is achieved.

To obtain the desired result,

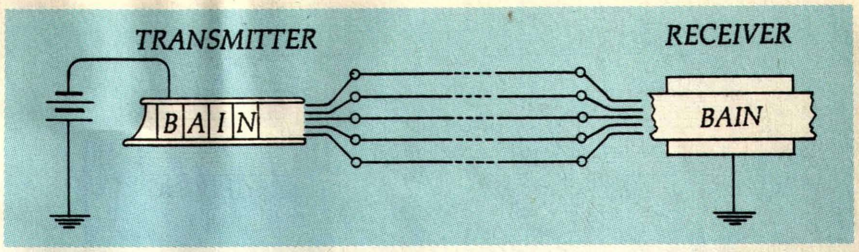


FIG. 1—BAIN'S FACSIMILE MACHINE. Chemically-treated paper darkened where current from brushes contacted embossed metal type in 1842.

the image must be broken down into successive points of light and dark or as a mosaic of picture elements or *pixels*. This has become possible because of the invention of different methods for object scanning. The elements of the mosaic are translated into electrical impulses in successive rows of elements called lines. The closer together these scanning lines are, the higher will be the definition of the picture.

The succession of lines that form a picture is called a frame, and the number of frames per second is the repetition rate. Thus, persistence of vision combined with a frame rate that exceeds the human eye's *flicker* rate (about 30 frames per second) are both necessary for viewing television.

Morse's contribution

Samuel F.B. Morse, a portrait painter, established the basic principles of all electromagnetic communications when he demonstrated his telegraph system in 1844. Although the discovery that electric current flows through a wire had been made earlier, it was Morse who first demonstrated that messages could be transmitted by interrupting that current to form a series of long and short pulses or dots and dashes.

With a battery (later voltage from a central station), a sending key, a receiver that would make a noise, and a connecting wire, the first telegraph system was assembled. The key activated the sounder's electromagnet, and the electromagnet then caused the sounder to make an audible click. The telegraph inspired many investigators to believe that if messages could be transmitted over wires, pictures could also be transmitted.

Facsimile shows up

One of the first television researchers, English physicist Alexander Bain, built apparatus that could transmit characters and words over wire in 1842. This apparatus, shown in Fig. 1, was a crude version of a facsimile machine. It depended on embossed metal type, similar to that used for printing newspapers, and metal brushes which moved horizontally across chemically treated paper in contact with the type.

The chemically treated paper conducted current that darkened the paper as it passed from the brush to the embossed metal typeface underneath. A character pattern of the underlying letter was formed on the paper, and the signal was then sent over a bundle of wires to an identical setup at the receiver that reformed the letters.

The difficulty with Bain's system was that the brushes at the receiver had to be synchronized with those at the transmitter. This was not easy to accomplish with the technology available at that time. But Bain succeeded in demonstrating a practical way to scan characters line-by-line and transmit words and text or graphics. a technique that is fundamental to modern television.

In 1847, another inventor named Bakewell improved on Bain's machine, as shown in Fig. 2. Bakewell replaced the bundle of wires that connected the transmitter and receiver with a single wire. Then, instead of scanning a flat surface, he set up a pair of cylinders that revolved synchronously.

DID YOU KNOW THAT?

- The first text was transmitted by wire in 1842.
- Pictures were transmitted by wire between Paris and Amiens in France in 1862.
- Nipkow invented the mechanical scanning of moving objects in 1884.
- Baird demonstrated live television broadcasting in 1923.
- Zworykin invented the iconoscope camera tube for electronic scanning in 1923.
- Farnsworth invented the improved image orthicon picture tube in 1928.
- Electronically-scanned television became a reality in 1933.

A drum with tin foil wrapped on it was located at the transmitter end. A picture to be transmitted was painted on the foil with shellac. When needle N1 contacted the foil, it closed the circuit permitting a current to flow to needle N2 at the receiver. However, when needle N1 moved over the shellac drawing, no current flowed.

The real significance of Bakewell's apparatus was in its ability to demonstrate automatic signal switching and scanning, not in its ability to transmit a picture over a wire. Mechanical linkage connected both cylinders so they turned at the same speed, eliminating the difficulty in synchronizing the brushes Bain invented. Synchronized transmitted and received signals is another requirement for modern television. Unfortunately, the mechanical linkage limited the distance between transmitter and receiver to distances measured in feet.

Bakewell's apparatus had another serious handicap: The image at the receiver was not only monochrome, but it was monotone as well. The apparatus did not make possible gray shades or tone gradations from black to white. The signal transmitted on the wire conductor from the transmitter to the receiver consisted only of pulses of uniform amplitude. The only difference between pulses was in their duty cycle (ratio of on-to-off time), not strength.

Many researchers attempted to improve on what Bain and Bakewell had done. In 1865, two

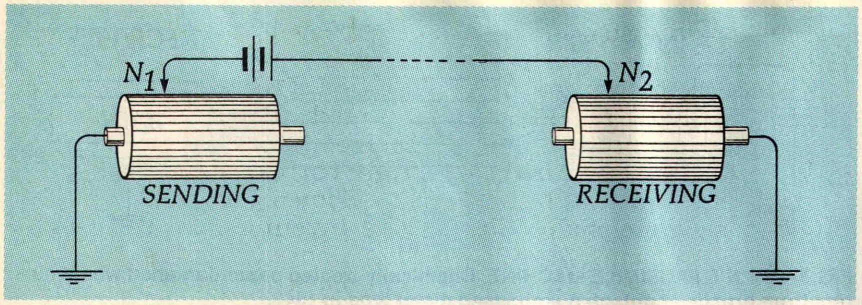


FIG. 2—BAKEWELL'S SYSTEM had tin-foil covered revolving drums for transmitting and receiving recorded pictures in 1847.

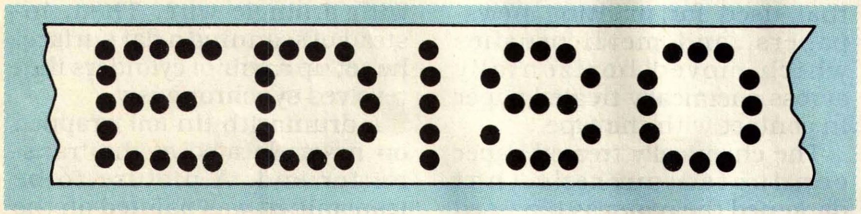


FIG. 3—THOMAS EDISON experimented with sending letters and words punched in tape by telegraph in 1873.

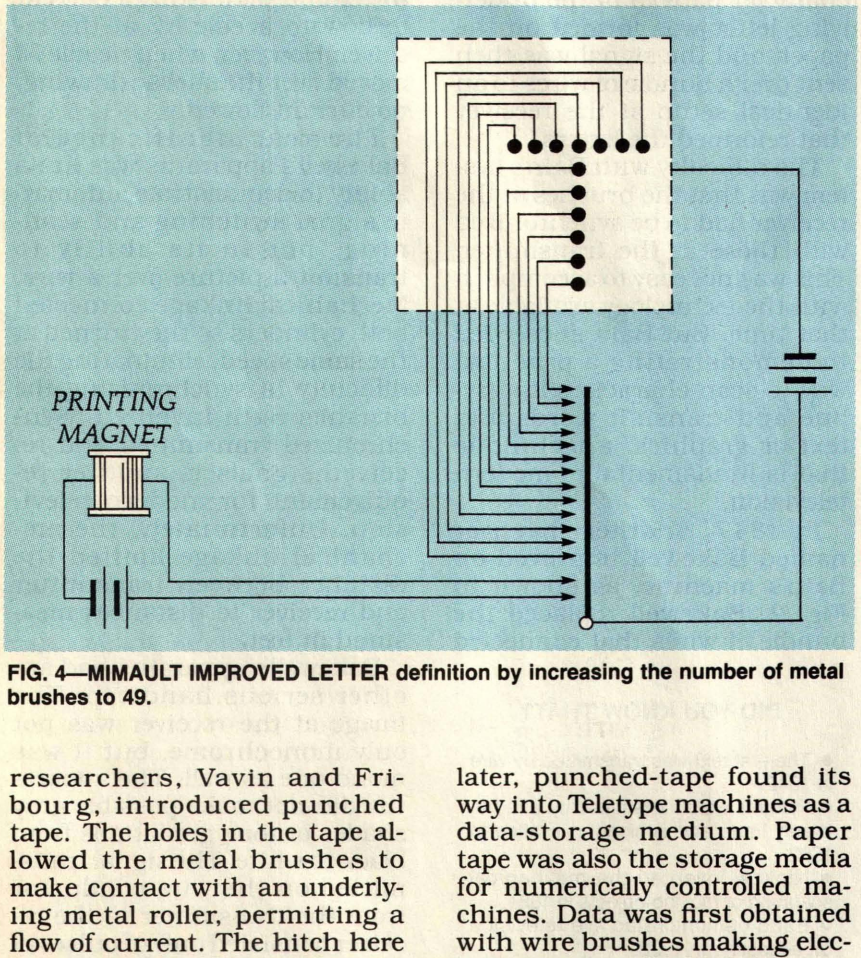


FIG. 4—MIMAULT IMPROVED LETTER definition by increasing the number of metal brushes to 49.

researchers, Vavin and Fribourg, introduced punched tape. The holes in the tape allowed the metal brushes to make contact with an underlying metal roller, permitting a flow of current. The hitch here was that the reproduced images were discontinuous, making the system unsuitable for transmitting complete pictures.

Thomas Edison began experimenting with punched tape in 1873, as shown in Fig. 3. Years later, punched-tape found its way into Teletype machines as a data-storage medium. Paper tape was also the storage media for numerically controlled machines. Data was first obtained with wire brushes making electrical contact through holes in the paper tape, but later the brushes were replaced by solid-state optocouplers.

Another television pioneer, a Frenchman named Mimault, also used chemically-treated paper for receiving signals with as many as 49 metal pins for scanning. Figure 4 shows how Mimault transmitted the letter "T." M. Abbe Caselli, a French engineer, transmitted drawings and diagrams electrically over wires in 1862. Caselli's system improved over the apparatus of both Bain and Bakewell, but it was more than just a laboratory curiosity. It actually transmitted signals between Paris and Amiens in France for several years.

Even after the beginning of the 20th century, inventors were still hard at work trying to devise ever more practical wire transmission systems. One of these was the TelAutograph, an apparatus for transmitting writing and pictures. It produced facsimiles at the receiving end with an electrically controlled pen that made the same motions as the transmitting pen. Another system, Tele-Pantagraph, could transmit drawings over long distances by telegraphy.

Selenium contribution

Selenium has a place in this discussion because it was prominent in early television experiments. It was also the first semiconductor material to be used commercially, well before the invention of transistors. Although discovered in 1820, 56 years passed before it was discovered that selenium exhibited high sensitivity to light. This finding was exploited by the early pioneers who wanted to convert light energy to an electrical signal.

Selenium is still found in photoconductive cells, photoelectric light meters, and in the light-sensitive coating on the drums of xerographic copying machines and laser printers. The layer of selenium on the drums is electrostatically charged and then preferentially discharged by intense selective illumination.

The electrostatic image is transmitted to paper by dusting a plate with fine black or colored toner powder and then the image is "ironed"on the paper. Selenium rectifiers were popular replacements for rectifier tubes in the years before the introduction of silicon rectifiers and transistors.

A French inventor named M. Senlecq developed a system called the Telectroscope in 1877. The image to be transmitted was reflected onto the ground glass plate of a camera obscura. That image was then traced, line-by-line, with a fine-pointed selenium stylus.The current flowing from the transmitter to the receiver depended on the amount of light present at each tiny spot. This was the first system that received a picture consisting of variations in light level.

In 1880, Ayrton (the inventor of the Ayrton shunt), Perry, and Professor Kerr (inventor of the Kerr cell) proposed a television system based on selenium cells. Their arrangement consisted of many selenium cells, each containing multiple wires. Each of the cells contributed a small amount of current, and total current flow depended on the light reaching it. In effect, the system formed a mosaic. Many years later the mosaic concept would be adopted for the iconoscope camera tube.

The Ayrton-Perry-Kerr television system was interconnected with a large number of wires. At the receiver, a corresponding number of magnetic needles moved, permitting light of varying intensity to pass through an equal number of apertures. Kerr also developed a receiver based on electromagnets with silvered ends illuminated by a polarized beam of light. The currents flowing through the electromagnets rotated the plane of polarization as a function of the light received at any given moment.

The ability of selenium to change light energy to an electrical signal was inhibited by the crudeness of the early mechanical scanning systems. This disparity led many inventors to attempt improvement breakthroughs. Although the names of many of these inventors have been lost in the dustbin of history, Alexander Graham Bell took out a patent for a television system that included selenium components.

In 1880, a Boston inventor, named G.R. Carey, developed a system for transmitting the signal equivalents of picture elements simultaneously by setting up a separate channel for each picture element. His transmitter was a disk with holes drilled around the periphery, as shown in Fig. 5. Each hole contained a selenium element connected to a transmission wire.

As an image was focused on this disk, it was broken up into as many picture elements as there were holes in the disk. Cary deserves credit as the inventor of the multichannel transmission system.

Light entered the right side of the cylinder where it activated many selenium cells. The electrical output of all of the cells was then brought out by individual wires to a sheet of chemically treated paper. The current in each wire altered the composition of the paper to produce a reproduction of the subject. Each of the selenium cells effectively corresponded with picture elements or pixels.

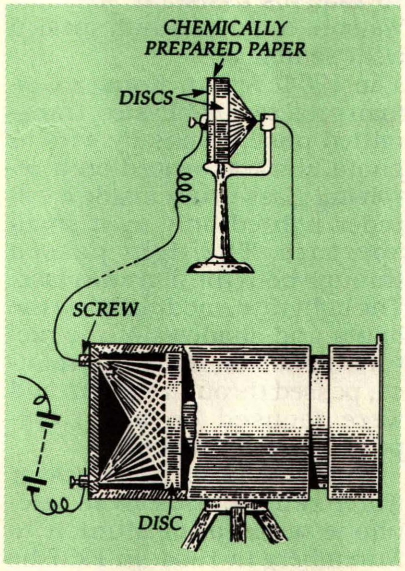


FIG. 5—CAREY TRANSMITTED pictures over wire bundles in 1879.

An inventor named De Bernouchi invented apparatus that eliminated the multiple wires. Figure 6 is a drawing of the apparatus. A light source (shown at the left) was focused by a lens onto a drum, around which was wrapped photographic film. The light from the film, varying in strength and dependent on light and dark areas of the film, was reflected by a prism onto a selenium cell, varying its resistance value.

The selenium circuit consisted of the selenium cells, a DC voltage source, and the primary (P) of a transformer. The signal appearing across the secondary (S) of the transformer modulated the light produced by an arc lamp, a source of high-intensity light. The light reflected from a parabolic reflector onto a mirror before it passed through a lens onto a drum coated with a photosensitive material.

Mechanical scanning invented

In 1883, Paul Nipkow, a German television pioneer, invented the perforated spiral distributing disk or mechanical scanner. His electrical telescope was notable as the first successful method for scanning moving images. It remained in use through the late 1920s, but eventually was replaced by electronic scanning in the 1930s.

A series of perforations was arranged in a spiral pattern around the peripheries of iden-

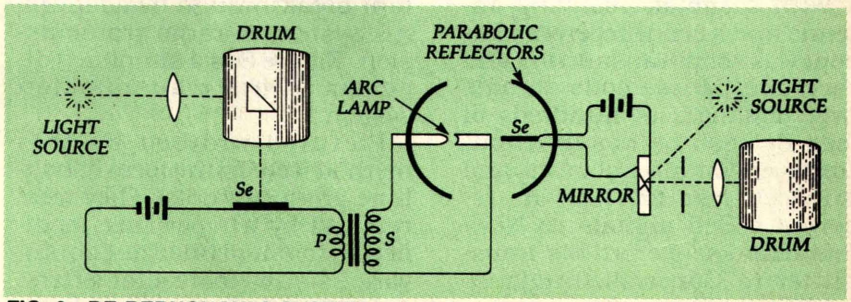


FIG. 6—DE BERNOUCHI'S SYSTEM included selenium cell transducers and an arc lamp as a light source.

tical disks. One transmitted the picture elements and the other received them, as is shown in Fig. 7. Each hole in the disk passed in front of an aperture in succession as the disk revolved. This arrangement permitted moving pictures to be sent over wires and broadcast by radio.

Unfortunately, Nipkow was ahead of his time because neither light-sensitive cells, photoelectric cells, vacuum tubes, nor cathode-ray tubes had been invented. Moreover, there was no wireless in 1884 when Nipkow was granted his patent. The work of Hertz and Marconi was yet to be done

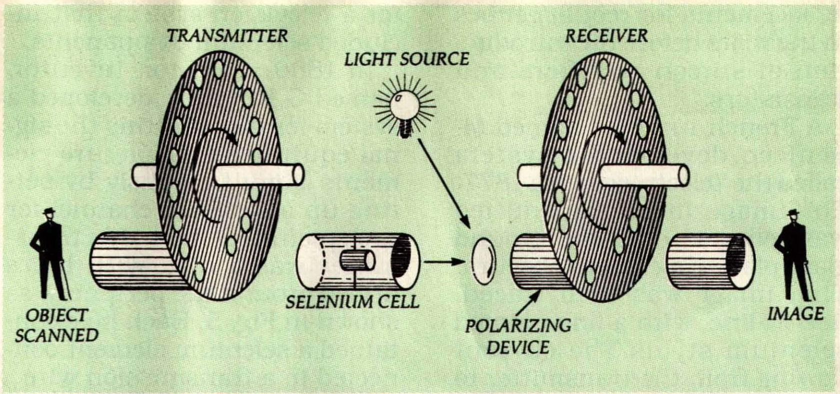


FIG. 7—NIPKOW'S PERFORATED SPIRAL DISK made mechanical scanning a reality in 1884.

Transmission by radio

Morse inaugurated his telegraph system in 1844, 40 years before Heinrich Hertz, a German scientist, built his experimental apparatus that first transmitted feeble radio signals generated by man through space. Hertz carried out his landmark experiments in radio wave transmission with an oscillator as a crude transmitter and a detector forming a crude receiver. He confirmed the theory proposed by the English physicist, Clerk Maxwell, that radio waves differ from light waves only in wavelength and frequency.

But it remained for Guglielmo Marconi, an Italian engineer, to pick up where Hertz left off and startle the world with practical radio transmission. And he did it without vacuum tubes! Marconi built an induction coil and an oscillator which he connected to an antenna, permitting him to generate and radiate far stronger modulated electromagnetic waves than Hertz could produce.

With a similar receiving antenna and a crude receiver, Marconi was soon transmitting and receiving Morse code signals over distances of hundreds of feet. By 1895 he was transmitting over distances of miles, and on December 12, 1901 he received coded signals in Newfoundland sent from his transmitter in Cornwall, England, 2,170 miles away.

Some 30 years passed from the inauguration of Morse's telegraph until Alexander Graham Bell, a Scottish-American speech professor and teacher of the deaf, accidentally stumbled on the apparatus that would later become the telephone. However, it took Bell nearly another year of diligent experimentation before he was able to improve his apparatus enough so that his assistant, Thomas Watson, could hear him speak a clear sentence.

In 1904, Arthur Korn, a German professor of physics, transmitted photographs by wire. A photo film was placed on a revolving glass drum inside a cylinder lighted only by a small aperture. The light passed through both the film and glass. The light rays, modulated by the lights and shadows of the picture on film as the drum rotated, passed through a prism and were focused on a battery-powered selenium cell.

With this system, Professor Korn sent photos over telephone wires from Munich to Nuremberg in 1904. In 1907 he sent wire photos from Europe to England. However, in 1922 Professor Korn achieved an important breakthrough by adapting his system to radio transmission. Figure 8 is a simplified diagram of his transmission system.

Pictures radioed by this method were in the form of halftone groups of dots. They were received by a typewriter modified so that it printed out dots of various sizes instead of letters. A picture was radioed from Berlin to Maine in 1922 in about 40 minutes.

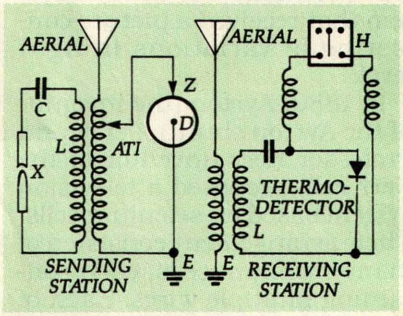


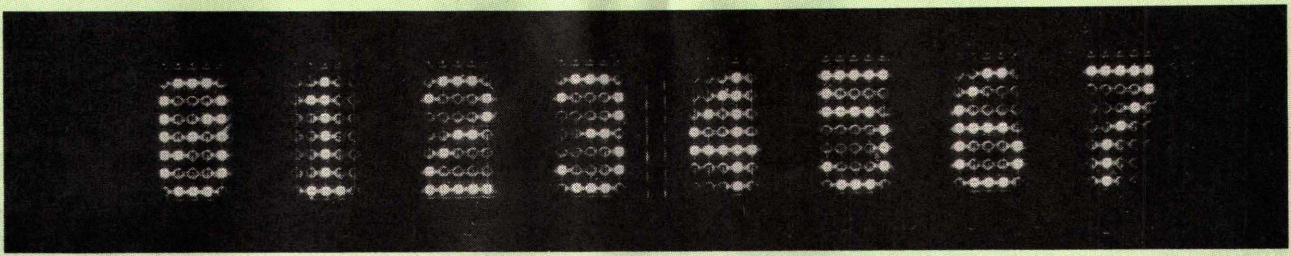
FIG. 8—KORN TRANSMITTED pictures over wire before devising a system for broadcasting them by radio in 1922.

The Bell Telephone Laboratories improved on Professor Korn's original invention by developing a system of phototelegraphy. It was similar to Korn's invention, but with some important modifications: A photoelectric cell replaced the selenium cell, and the rotating cylinders were kept synchronized by electrical tuning forks.

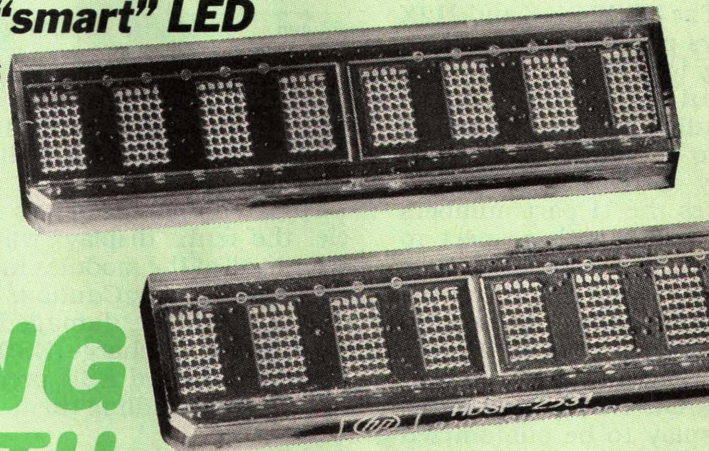
Although the Bell Laboratories improved upon Korn's work, the laboratories were interested only in transmitting pictures over telephone lines while Korn is credited with moving television into the realm of radio broadcasting.

John Baird, a Scottish inventor, devised a system that projected televised shadows onto a screen, and he was the first person to demonstrate television to the public in 1923. Baird's transmitter consisted of a Nipkow disk that had 17 lenses in each of its peripheral perforations. The object to be televised was strongly illuminated and lo-

Continued on page 74



Learn how to program "smart" LED multicharacter displays with your computer.



WORKING WITH SMART DISPLAYS

JERRY R. LETTOW

CONVENTIONAL LIGHT-EMITTING DIODE display modules require peripheral devices such as ASCI decoders and drivers to drive and control them. However, later generation LED displays contain these and other functions, such as display multiplexing and character memory. This component consolidation saves circuit board space, assembly time, and cost, and it makes the newer displays compatible with and controllable by microprocessors and microcontrollers. Consequently, they are called "smart" or "intelligent" displays."

Conventional numeric and alphanumeric LED modules displays are found in a wide range of consumer appliances and entertainment products as well as business machines, medical equipment, and test equipment. These single or multi-character modules are typically priced under $5, However, the cost of a complete display system adds up when the price peripheral devices and assembly labor are included. Moreover, a multicomponent display system occupies several square inches of the circuit board's "real estate."

Smart or intelligent LED displays can be found in telecommunications equipment, portable telephones, bench test equipment, airborne electronics, and medical equipment. The least expensive eight-character alphanumeric LED dot-matrix modules are priced at about $40. They can display numbers, letters, and symbols in a rapid sequence to form messages under computer control. When stacked end-to-end or side-by-side they can spell out complete sentences. When packaged in familiar dual-in line cases with 0.10-inch pin spacing (pitch), the modules can be plugged into standard sockets or soldered directly to circuit boards.

The subject of this article is the HDSP211X-212X-250X series of eight -digit LED alphanumeric, dot-matrix displays made by Hewlett-Packard. This article will explain how they can be programmed to present messages under the control of an IBM or compatible personal computer. In addition to providing the background and information you'll need if you want to add a "smart" LED display to your own project, the article is a practical introduction to the subject of interfacing personal computers with external devices and circuits.

The HDSP211X-212X family

There are 11 different part numbers in the Hewlett-Packard HDSP-211X/-212X/250X series Figure 1 is an outline drawing for the HDSP-211X and HDSP-212X products. (The HDSP-250X package is 2.79 inches long and each of its dot-matrix arrays are about 35 % larger.) All of the displays have 28 pins in a standard DIP outline with 0.6-inch spacing between pin rows.

The characters on the HDSP-211X and HDSP-212X series are approximately 0.2 inch high while those on the HDSP-250X series are about 0.275-inch high. The on-board CMOS ICs in the HDSP-211X and HDSP-250X displays decode 128 ASCII characters while those on the HDSP-212X decode Japanese Katakana characters.

All characters are permanently stored in the device's ROM. The HDSP-211X and 212X displays can be stacked horizontally to achieve a longer display, but the HDSP-250X display outline dimensions permit them to be stacked both horizontally and vertically. Table 1 identifies the 11 part numbers in the series with respect to character size, LED color, and the ability to display either the ASCII or Katakana characters.

All displays can store 16 user-programmable symbols in on-board RAM. This feature allows the display to be customized with additional symbols and icons. Seven brightness levels permit the adjustment of display intensity and, as a consequence, power consumption. All displays in the series are designed to be compatible with standard microprocessor interface electronics and each display and its special features can be accessed through a bidirectional eight-bit bus.

TABLE 1
HDSP ALPHANUMERIC DISPLAYS

Color	Character Set	
	ASCII	Katakana
Red	HDSP-2112 HDSP-2502	HDSP-2122
Orange	HDSP-2110 HDSP-2500	
Yellow	HDSP-2111 HDSP-2501	HDSP-2121
Green	HDSP-2113 HDSP-2503	HDSP-2123

For the remainder of this article, the term "display" will be refer to all of the modules in the series collectively. *Caution:* The displays can be damaged by electrostatic discharge (ESD) so observe standard ESD precautions when handling them.

Demonstration system

The display is primarily intended for installation in products that permit it to be controlled by an embedded microprocessor or microcontroller. This article explains how an IBM PC or compatible computer can be used to demonstrate the display's operation and programmability. Only a simple interface circuit and a C-language compiler are needed for the PC to control the display.

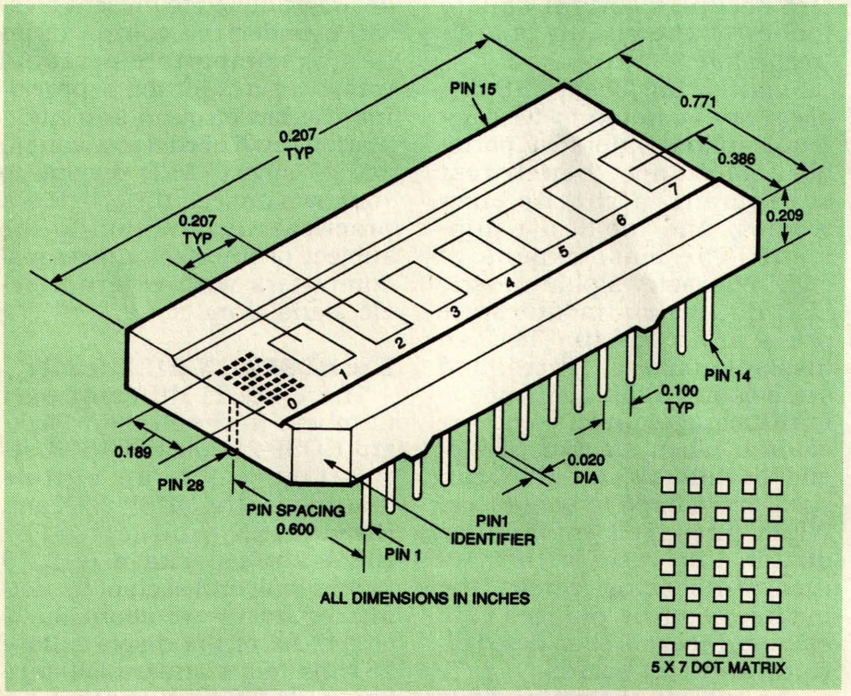


FIG. 1—PRINCIPAL DIMENSIONS of HDSP-211X /212X eight-character, smart alphanumeric LED displays. Characters are formed by a 5×7 LED dot matrix. HDSP-250X displays are longer and have larger characters. Both are in 28-pin DIP packages with standard 0.6-inch spacing.

The interface circuit is built on a single PC compatible plug-in card. It contains a standard port address selector circuit and an Intel 8255A programmable peripheral interface. There is also room on the card to mount the display.

the software presented here is compatible with the Borland Turbo C++ compiler. Compilers from other publishers might require some software syntax modification for the code to operate properly.

Port address selector

Figure 3 is the schematic for the single circuit board on which all circuit components and display are mounted. The port address selector circuitry, the 8255A and the display were all mounted on a PR2 prototype from JDR Microdevices (2233 Samaritan Drive, San Jose, CA 95124; 1-800-538-5000).

This board consists of two sections. One has the silk-screened outline for the correct parts placement for all the components of the port addressess selector circuit on both sides of the card, as shown in the photograph. In addition, the card has an open matrix on holes 0.10 inch on centers for mounting and wiring the 8255A and display. The company also offers a hardware kit for the installation of the PR2.

A computer must perform three steps to send data to an external device such as the 8255A. First its I/O write line must be set to a logic low. Then the address of the destination of the data must be sent on its address lines. Finally, the computer must send that data on its data lines. In Turbo C++, the instruction that performs an I/O write is:

outportb(*address, data*)

Refer to Fig 3. Whenever an outportb( ) instruction is executed, pin 15 of IC2, a 74LS244 noninverting octal three-state driver goes to logic low. The 74LS244 is a byte-wide line

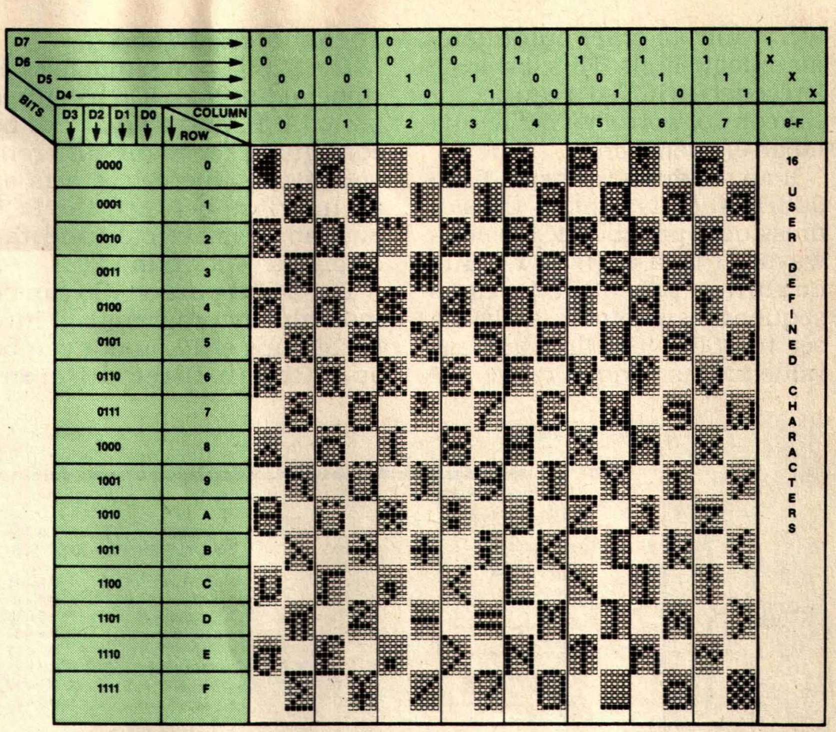


FIG. 2—ASCII CHARACTER SET for HDSP-211X and HDSP-250X series of LED alphanumeric displays.

driver whose enable pins are tied to ground. Consequently, it acts as a noninverting buffer and pin 5 of IC2 also goes logic low. This then causes pin 4 of IC4, (one quarter of an 74LS00 quad, two-input NAND gate)and pin 36 of IC8 (the 8255A) to go logic low. All other inputs to IC2 remain at the proper inactive levels.

Next, the address of the port to be addressed appears at the port selector circuitry. This circuitry is organized so that the port resides at a range of 300H to 303H.

When data is sent to that address, the computer places the binary code 1100000000 on its address lines A0 to A9 where A9 is the most significant bit (300 hex = 1100000000 binary). The address lines are buffered by IC2 and IC3. Buffered address lines A5 to A9 are fed to IC6, where they are compared with the logic leves set by switch S1.

PARTS LIST

Resistors (¼- watt, 10%)
R1, R2, R3, R4, R5—4700 ohms
R6—2200 ohms
Capacitors
C1, C2—10 µF, 63 volts, aluminum electrolytic capacitor
C3, C4, C5, C6, C7—0.1µF, ceramic disk
Semiconductors
IC1—74LS245, noninverting octal bus transceiver
IC2, IC3—74LS244, noninverting octal 3-state driver
IC4—74LS00, quad 2-input NAND Gate
IC5—74LS138, 1 of 8 decoder/demultiplexer
IC6—74LS85, 4-bit magnitude comparator
IC7—74LS08, quad 2-input AND gate
IC8—8255A programmable peripheral interface, Intel or equivalent.
IC9—HDSP-211X eight character alphanumeric LED display, Hewlett-Packard or equivalent
Other components
S1—switch, four-position, dual-in-line, PCB mount
Miscellaneous: eight-bit prototype card (see text); parts kit for prototype card (see text); header pins for wire wrapping (1×20, straight male); socket, 40-pin wire-wrap; socket, 28-pin wire-wrap, hookup wire, solder.
Note: The following items are available from Staletto Solutions, 484 McCamish Avenue, San Jose, CA 95123.
- **Computer disk containing complete article source code listings including two menu driven HDSP-211X demonstration programs and source code—$7.50**
- **Assembled and tested circuit on a prototype card (8255A and HDSP-211X not included)—$75.00. Items 1 and 2—$100.00 Send check or money order. Add $2.50 for shipping and handling. California residents add local sales tax.**

TABLE 2
HEADER TO 8225 PIN CONNECTIONS

FROM: Header Pin	TO: 8255A
Data D0*	34
Data D1*	33
Data D2*	32
Data D3*	31
Data D4*	30
Data D5*	29
Data D6*	28
Data D7*	27
I/O IOR	5
I/O IOW	36
Select 0	6
Address A0*	9
Address A1*	8

*Buffered

Because input pin 3 of IC6, a 74LS85, four-bit magnitude comparator is logic high, all remaining inputs should be equal.Thus, the input logic levels at pins 10, 11, 14, and 15 of IC6 should equal the logic levels at pins 9, 12, 13, and 1, in that order.

Position 1 of S1 must be OFF to produce a logic high level input to pin 9 of IC6. This, in turn, equals the logic level on pins 10, and all other switch S1 positions should be ON. When IC6 detects a match, its output pin 6 goes logic high.

Simultaneously, the outputs pins 16, and 5 of IC2 have been gated to produce a logic high at input pin 12 of IC4. This high input level is gated with the high output level from pin 6 of IC6 to produce a logic low at input pins 12 and 13 of IC7, one quarter of a 74LS08 quad-two-input AND gate and pin 4 of IC5,an 74LS138 1 of 8 decoder/demultiplexer.

The low logic level output of pin 11 of IC7 is then gated to pin 19 of IC1, a 74LS245 octal bidirectional three-state transceiver. IC1 then passes a buffered control word from pins 11 to 18 (B8 to B1) of IC1 to pins 27 to 23 (D7 to D0) of IC8, the 8255A. However, IC8 must be enabled.

When the logic low appears at input pin 4 of IC5, it is decoded along with the other inputs to produce a logic low at pin 15 of

IC5, while all other outputs remain logic high. This low logic level enables IC8 so it can accept the control word that defines its mode of operation.

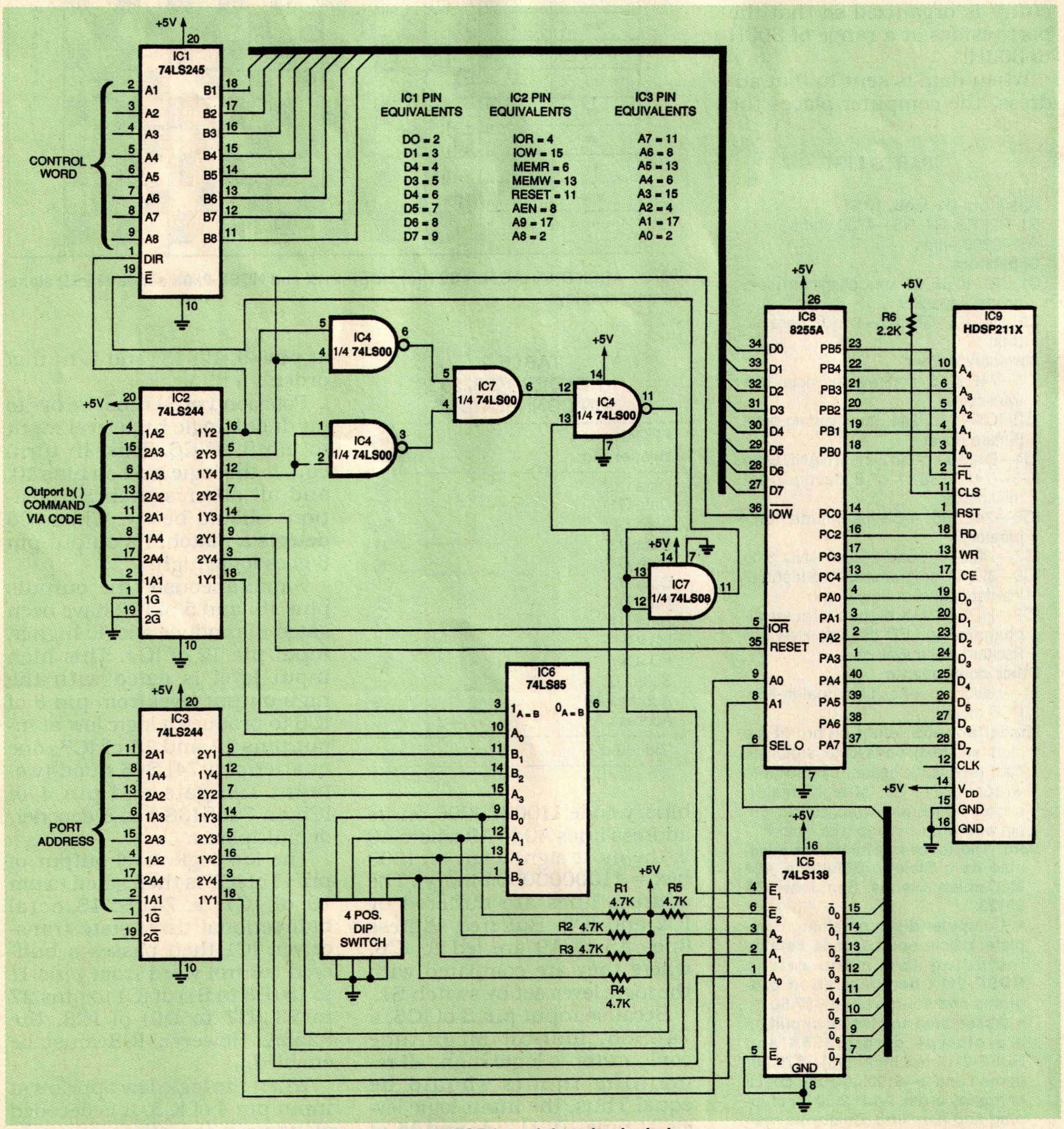
If any address in the 300H to 303H range is sent to the address bus, pin 15 of IC5 will always go to a logic low, thus enabling the 8255A. Consequently switch S1 is always set to 300H, the first address value in this address range.

Theory of the 8255A

The 8255A programmable peripheral interface IC8 has three ports (A, B, and C) that can be configured for many different operations. The device acts as an interface between the PC's port address selector and the display, as shown in Fig. 3.

The 24 I/O pins on IC8 can be individually programmed into two groups of 12, and it can be operated in three different modes. (Refer to a manufacturer's data book for more information on the 8255A.) The prime source is Intel, but it is alternate sourced by NEC (μPD8255-A) and Oki (MSM8255A).

The 8255A (IC8) can be programmed by sending a control word to its data input lines D0 to D7 while the A0 and A1 lines are held low. That control word initializes IC8 to run in any one



+5V
IC1
74LS245
A1
A2
A3
A4
A5
A6
A7
A8
DIR
Ē
B1
B2
B3
B4
B5
B6
B7
B8
CONTROL WORD
IC1 PIN EQUIVALENTS
DO = 2
D1 = 3
D4 = 4
D3 = 5
D4 = 6
D5 = 7
D6 = 8
D7 = 9
IC2 PIN EQUIVALENTS
IOR = 4
IOW = 15
MEMR = 6
MEMW = 13
RESET = 11
AEN = 8
A9 = 17
A8 = 2
IC3 PIN EQUIVALENTS
A7 = 11
A6 = 8
A5 = 13
A4 = 6
A3 = 15
A2 = 4
A1 = 17
A0 = 2
IC2
74LS244
Outport b( ) COMMAND VIA CODE
1A2
2A3
1A3
2A2
2A1
1A4
2A4
1A1
1G
2G
1Y2
2Y3
1Y4
2Y2
1Y3
2Y1
2Y4
1Y1
IC4
1/4 74LS00
IC7
1/4 74LS00
IC7
1/4 74LS08
IC3
74LS244
PORT ADDRESS
IC6
74LS85
$1_{A=B}$
$0_{A=B}$
A_0
B_1
B_2
A_3
B_0
A_1
A_2
B_3
4 POS. DIP SWITCH
R1 4.7K
R2 4.7K
R3 4.7K
R4 4.7K
R5 4.7K
R6 2.2K
IC8
8255A
D0
D1
D2
D3
D4
D5
D6
D7
IOW
IOR
RESET
A0
A1
SEL O
PB5
PB4
PB3
PB2
PB1
PB0
PC0
PC2
PC3
PC4
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
IC9
HDSP211X
A_4
A_3
A_2
A_1
A_0
FL
CLS
RST
RD
WR
CE
D_0
D_1
D_2
D_3
D_4
D_5
D_6
D_7
CLK
V_{DD}
GND
GND
IC5
74LS138
$\bar{E}_1$
$\bar{E}_2$
A_2
A_1
A_0
$\bar{0}_0$
$\bar{0}_1$
$\bar{0}_2$
$\bar{0}_3$
$\bar{0}_4$
$\bar{0}_5$
$\bar{0}_6$
$\bar{0}_7$
GND

FIG. 3—SCHEMATIC FOR THE PORT ADDRESS SELECTOR board that also includes an 8255A programmable interface and an HDSP211X series alphanumeric display.

of its three modes. Selection of those modes depends on the value of the control word. In this project IC8 will run in mode 0, selected by sending binary 10000000 to the 8255A's data lines identified earlier.

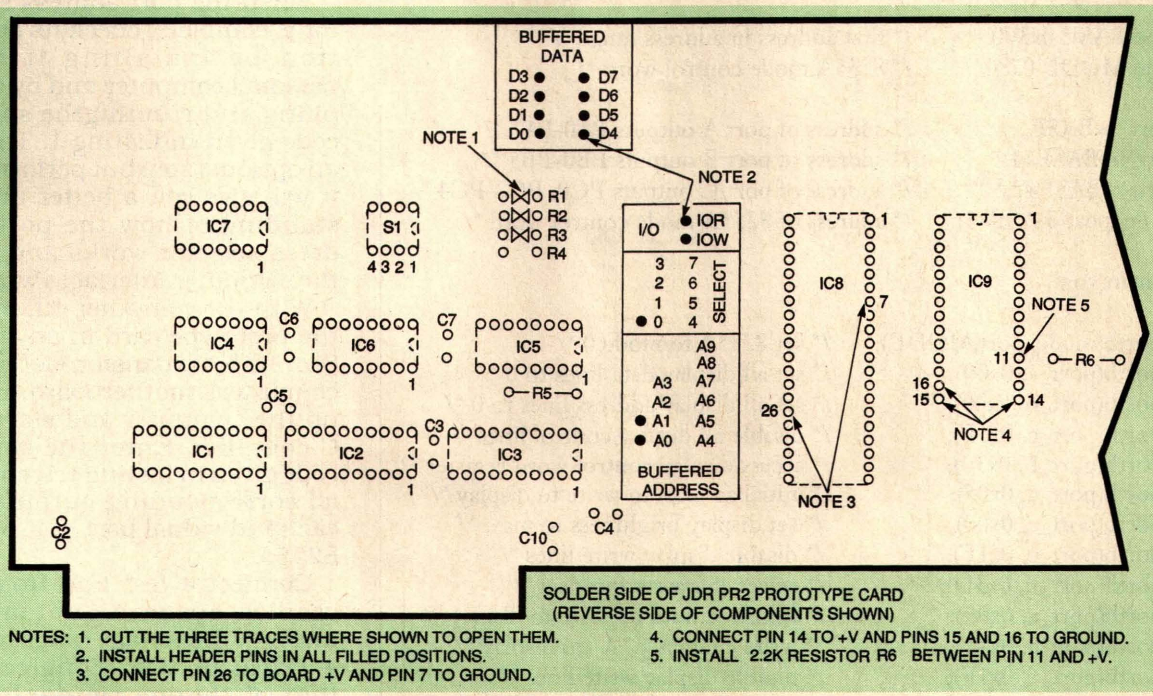
Mode 0 was selected because it simplifies the output operations for each of the three on-board ports of IC8 by eliminating the need for "handshaking."

In mode 0, ports A and B (PA0 to PA7 and PB0 to PB7, respectively) are operated as eight-bit data output buffers. Port C is divided into two four-bit data output buffers (PC0 to PC3 and PC4 to PC7, respectively).

Port selection depends on the logic levels related to the IC8 (8255A) inputs A0 to A1 (pins 9 and 8). The control word address port is always the last port value in all address ranges. For this reason, port A is assigned to address 300H, port B is assigned to address 301H, and port C is assigned to address 302H. The IC8 mode control address is 303H. Thus, to set IC8 to mode 0, the control word 10000000 (80H) is placed on data input lines D0 to D7 and sent to address 303H. Listing 1, the first eight lines of the Turbo C+ source code, performs the operation.

LISTING 1

```
#include <stdio.h>
#include <dos.h>

#define BASE   0x300          /* First address in address range */
#define MODE   0x80           /* 8255A mode control word */

int port_a = BASE,            /* address of port A outputs PA0 - PA7 */
    port_b = BASE+1,          /* address of port B outputs PB0 - PB5 */
    port_c = BASE+2,          /* address of port C outputs PC0, PC2 - PC4 */
    mode_port = BASE+3;       /* address of 8255A control word port */
void main(void)
{
        outportb(mode_port, MODE);    /* set 8255A to mode 0 */
        outportb(port_a, 0);          /* initialize port A outputs to LOW */
        outportb(port_a, 1);          /* toggle PA0 to HIGH level */
        outportb(port_a, 2);          /* toggle PA1 to HIGH level */
        outportb(port_a, 4);          /* toggle PA2 to HIGH level */
        outportb(port_a, 8);          /* toggle PA3 to HIGH level */
        outportb(port_a, 16);         /* toggle PA4 to HIGH level */
        outportb(port_a, 32);         /* toggle PA5 to HIGH level */
        outportb(port_a, 64);         /* toggle PA6 to HIGH level */
        outportb(port_a, 128);        /* toggle PA7 to HIGH level */
        outportb(port_b, 0);          /* initialize port B outputs to LOW */
        outportb(port_b, 1);          /* toggle PB0 to HIGH level */
        outportb(port_b, 2);          /* toggle PB1 to HIGH level */
        outportb(port_b, 4);          /* toggle PB2 to HIGH level */
        outportb(port_b, 8);          /* toggle PB3 to HIGH level */
        outportb(port_b, 16);         /* toggle PB4 to HIGH level */
        outportb(port_b, 32);         /* toggle PB5 to HIGH level */
        outportb(port_c, 0);          /* initialize port C outputs to LOW */
        outportb(port_c, 1);          /* toggle PC0 to HIGH level */
        outportb(port_c, 4);          /* toggle PC2 to HIGH level */
        outportb(port_c, 8);          /* toggle PC3 to HIGH level */
        outportb(port_c, 16);         /* toggle PC4 to HIGH level */
}
```



NOTES: 1. CUT THE THREE TRACES WHERE SHOWN TO OPEN THEM.
2. INSTALL HEADER PINS IN ALL FILLED POSITIONS.
3. CONNECT PIN 26 TO BOARD +V AND PIN 7 TO GROUND.
4. CONNECT PIN 14 TO +V AND PINS 15 AND 16 TO GROUND.
5. INSTALL 2.2K RESISTOR R6 BETWEEN PIN 11 AND +V.

FIG. 4—PARTS PLACEMENT for the port address selector on a JDR PR2 prototype card (viewed from reverse or solder side).

By referring to both Fig. 3 and Listing 1, it can be seen that the display's data lines (D0 to D7) are accessed through port A. In addition, the address lines A0 to A4 and $\overline{\mathrm{FL}}$ line are controlled by port B, and all display control lines ($\overline{\mathrm{WR}}$, $\overline{\mathrm{CE}}$, $\overline{\mathrm{RST}}$, $\overline{\mathrm{RD}}$) are connected to port C.

Writing data to the display consists essentially of making use of the Turbo C + source code to send the IC8 (8255A) mode control word to the correct port address, setting the display control lines and address lines to the proper levels through ports B and C, and then transmitting the display data through port A.

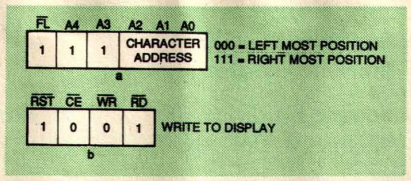


FIG 5—LOGIC LEVELS to select and display an ASCII character at a specified location.

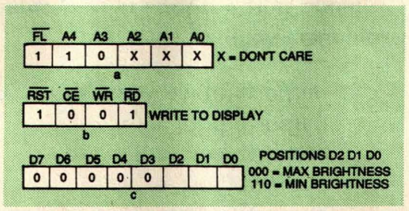


FIG 6—LOGIC LEVELS to select one of seven brightness levels.

Building the port selector

Refer to parts placement diagram Fig. 4. Note: This diagram is drawn to represent the *solder* side of the prototype card so that all pin numbers of IC will be seen as viewed from the bottom side rather than the top,a convenience when wire wrapping the pins.

Insert all components except IC8 (8255A) and IC9 (display) on the *component* side of the board for direct soldering. This is indicated by the screened callouts on the circuit board. (ICs 8 and 9 are to be inserted later.) Insert and solder 2.2-kilohm resistor R5 as shown on Fig. 5 between pin 6 of IC5 and the power lead. All capacitors on this circuit board decouple the power supply.

LISTING 2

```
/*
 * This listing shows how to write an "A" to the third HDSP-21XX
 * character location from the right.
 */

#include <stdio.h>              /* header files */
#include <dos.h>

#define BASE 0x300              /* first address in address range */
#define MODE 0x80               /* 8255A mode control word */

int port_a=BASE,                /* address of port A outputs PA0-PA7 */
    port_b=BASE+1,              /* address of port B outputs PB0-PB5 */
    port_c=BASE+2,              /* address of port C outputs PC0, PC2-PC4 */
    mode_port=BASE+3;           /* address of 8255A mode control word */

void main(void)
{
  outportb(mode_port,MODE);     /* set 8255A to mode 0 */
  outportb(port_a, 0x00);       /* set all display data lines to 0 */
  outportb(port_b, 0x00);       /* set all display address lines to 0 */
  outportb(port_c, 0x1F);       /* disable all display control lines */
  outportb(port_b, 0x30);       /* access display control word register */
  outportb(port_c, 0x05);       /* initialize lines to write to display */
  outportb(port_a, 0x00);        /* set display brightness to max. */
  outportb(port_c, 0x1F);        /* disable display write lines */
  outportb(port_b, 0x3D);        /* select character location */
  outportb(port_c, 0x05);        /* initialize lines to write to display */
  outportb(port_a, 0x41);        /* write character "A" to display */
  outportb(port_c, 0x1F);        /* disable display write lines */
}
```

When all the components except IC8 and IC9 have been inserted and soldered in their correct locations, insert wire-wrap header pins for IC8 at the positions specified on the solder side of the prototype card. Solder the header pins into the positions indicated by the heavy black circles shown in Fig. 4. Cut open the three conductive traces under resistors R1, R2, and R3 (shown to the left of the callouts on Fig. 4).

Installing the 8255A

Insert and solder a 40-pin wire-wrap socket in the prototype card, as shown in Fig. 4. Wire-wrap pin 26 of the IC8 (8255A) socket to the power supply trace, and connect pin 7 to the ground trace. Insert only IC8 in its socket at this time. Manually wire wrap the remaining header pins listed in Table 2.

Debugging the selector

When the port address selector is complete, check its operation by installing it in a personal computer and by compiling and runningthe source code given in Listing 1. This is an optional step but performing it will give you a better understanding of how the port address selector works and how the computer interfaces with it.

With the computer off, insert the prototype card in any open 8- or 16-bit expansion slot in the computer's motherboard. Bootup the computer and start the C-compiler. Enter the source code given in Listing 1. It checks all corresponding outputs for each individual port of IC8, the 8255A.

Connect a test lead from an oscilloscope or digital multimeter in the voltage range to pin 4 (PA0) of IC8. Single step through the program one line at a time with the C-compiler's de-

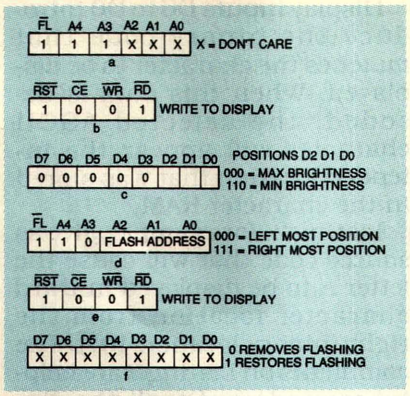

FL A4 A3 A2 A1 A0
1 1 1 X X X
X = DON'T CARE
a
RST CE WR RD
1 0 0 1
WRITE TO DISPLAY
b
D7 D6 D5 D4 D3 D2 D1 D0
0 0 0 0 0
POSITIONS D2 D1 D0
000 = MAX BRIGHTNESS
110 = MIN BRIGHTNESS
c
FL A4 A3 A2 A1 A0
1 1 0 FLASH ADDRESS
000 = LEFT MOST POSITION
111 = RIGHT MOST POSITION
d
RST CE WR RD
1 0 0 1
WRITE TO DISPLAY
e
D7 D6 D5 D4 D3 D2 D1 D0
X X X X X X X X
0 REMOVES FLASHING
1 RESTORES FLASHING
f

FIG. 7—LOGIC LEVELS to clear the flash and character RAMs and store a flash attribute for a specific character location.

COLUMN					ROW	UDC CHARACTER	HEX CODE
1	2	3	4	5			
D4	D3	D2	D1	D0			
1	1	1	1	1	1	• • • • •	1F
1	0	0	0	0	2	•	10
1	0	0	0	0	3	•	10
1	1	1	1	0	4	• • • •	1E
1	0	0	0	0	1	•	10
1	0	0	0	0	2	•	10
1	1	1	1	1	3	• • • • •	1F

FIG. 8—DATA TO LOAD letter E into the UDC RAM.

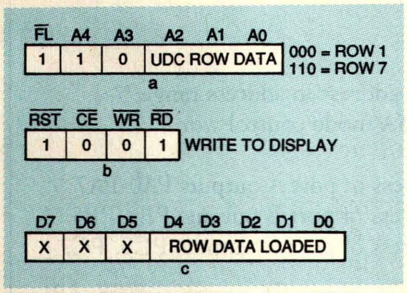

FL A4 A3 A2 A1 A0
1 1 0 UDC ROW DATA
000 = ROW 1
110 = ROW 7
a
RST CE WR RD
1 0 0 1
WRITE TO DISPLAY
b
D7 D6 D5 D4 D3 D2 D1 D0
X X X ROW DATA LOADED
c

FIG. 9— LOGIC LEVELS to load UDC row data into the UDC RAM.

bug function until the line outportb(port—a, 0) is reached. When this line has been executed, all port A outputs will be set to a low logic level. Then single step to the next line; outportb(port—a, 1). After this line has been executed, the DMM or oscilloscope should verify that pin 4 has switched to a logic high, indicating that IC8 is functioning properly.

Remove the test lead and connect it to the next port A output. Single step the source code one line and look for the high logic level. Repeat this procedure for the remaining outputs of ports A, B, and C. When checking port B, look only at outputs PB0 to PB5 (pins 18 to 23), and when checking port C, look only at output PC0 (pin 14) and outputs PC2, PC3, and PC4 (pins 16, 17, and 13).

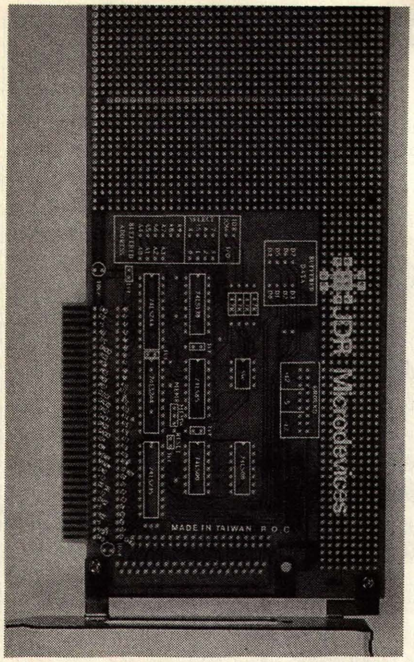
LISTING 3

```
/*
 *
 * This code writes an "A" to the 2nd and third HDSP-21XX
 * character locations from the left; the 2nd character location
 * then flashes and the third does not.
 */


#include <stdio.h>              /* header files */
#include <dos.h>


#define BASE 0x300              /* first address in address range */
#define MODE 0x80               /* 8255A mode control word */


int port_a=BASE,                /* address of port A outputs PA0-PA7 */
    port_b=BASE+1,              /* address of port B outputs PB0-PB5 */
    port_c=BASE+2,              /* address of port C outputs PC0, PC2-PC4 */
    mode_port=BASE+3;           /* address of 8255A control word port */


void main(void)
{
  outportb(mode_port,MODE);   /* set 8255A to mode 0 */
  outportb(port_a, 0x00);     /* set all display data lines to 0 */
  outportb(port_b, 0x00);     /* set all display address lines to 0 */
  outportb(port_c, 0x1F);     /* disable all display control lines */
  outportb(port_b, 0x30);     /* access display control word register */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x80);     /* clear flash and character RAMs */
  outportb(port_c, 0x1F);     /* disable display write lines */
  outportb(port_b, 0x01);     /* select 1st loc.of char.to be flashed */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x01);     /* store flash attribute at dig. location */
  outportb(port_c, 0x1F);     /* disable display write lines */
  outportb(port_b, 0x02);     /* select 2nd loc.of char.to be flashed */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x00);     /* disable flash attrib. at dig. location */
  outportb(port_c, 0x1F);     /* disable display write lines */
  outportb(port_b, 0x39);     /* select character location */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x41);     /* write character "A" to display */
  outportb(port_c, 0x1F);     /* disable display write lines */
  outportb(port_b, 0x3A);     /* select character location */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x41);     /* write character "A" to display */
  outportb(port_c, 0x1F);     /* disable display write lines */
  outportb(port_b, 0x30);     /* access display control word register */
  outportb(port_c, 0x05);     /* initialize lines to write to display */
  outportb(port_a, 0x0A);     /* find locations to flash and do it */
  outportb(port_c, 0x1F);     /* disable display write lines */
}
```

Display to 8255 connection

Install the display (IC9) *only* after proper port address selector operation has been verified. Insert a 28-pin wire-wrap socket for IC9 in the circuit board on the component side, checking its orientation (as seen from the solder side) with Fig. 4. Solder the socket in position.

Insert and solder 2.2-kilohm resistor R6 between the 5-volt power source and pin 11 of the display (IC9), as shown in Fig.



THE PR2 PROTOTYPE card from JDR MicroDevices identifies the parts locations for the port address selector circuit.

4. Wire-wrap all connections as shown in Fig. 3 after identifying all pin numbers and functions on the display, noting that the pins in Fig. 4 are bottom views.

Five-section display

The display has five functional sections: character RAM, control word register, flashing RAM, user-defined character (UDC) address register and UDC RAM. All five sections can be individually accessed by sending various logic levels to the address lines (A0 to A4 and the $\overline{\text{FLASH}}$ ($\overline{\text{FL}}$) line). Learn their functions by single-stepping through all the source code given in Listings 2, 3 and 4 as was done in testing the complete circuit and watching the effect on the display.

Character RAM

The display's eight-byte character RAM stores either ASCII character data or a UDC RAM address. One byte of RAM lis used for each of display's eight characters.Character RAM locations are selected by address lines A0 to A2.

Refer to Fig. 5-a. The character position is selected by setting the $\overline{\text{FL}}$ line and display address lines A4 and A3 to logic level 1 (high), while display address lines A2 to A0 are set to a value that matches a display digit location. For example, binary 000 corresponds to the display digit at the far left and binary 111 corresponds to the display digit at the far right.

Refer to Fig. 5-b. When the character location to be illuminated has been selected, set the $\overline{\text{RST}}$ line to logic level 1 (high), the $\overline{\text{CE}}$ and $\overline{\text{WR}}$ lines to a logic level 0 (low) and the $\overline{\text{CRD}}$ lines to 1 to permit writing any ASCII character shown in Fig. 2 at the selected location. Set display input D7 to 0, to enable the ASCII decoder.

Display inputs D6 to D0 introduce the binary code that matches the character to be displayed. When this data is decoded, the selected ASCII character will appear the intended location that was stored in the character RAM.

Listing 2, for example, give as source code that will cause the letter A to be displayed in third character location from the right (binary location 101). The comments on Listing 2 are helpful reminders. Recall the discussion of 8255A mode selection and port addressing as well as the command outportb( ). Consider the line:

LISTING 4

```
/*
 *
 * This listing writes an "A" to the third HDSP-21XX
 * character location from the right at max. brightness,
 * and then dims it to min. brightness.
 */

#include <stdio.h>              /* header files */
#include <dos.h>

#define BASE 0x300                       /* first address in address range */
#define MODE 0x80                        /* 8255A mode control word */

int port_a=BASE,                         /* address of port A outputs PA0-PA7 */
    port_b=BASE+1,                       /* address of port B outputs PB0-PB5 */
    port_c=BASE+2,                       /* address of port C outputs PC0, PC2-
PC4 */
    mode_port=BASE+3;                    /* address of 8255A control word port */

void main(void)
{
 outportb(mode_port,MODE);              /* set 8255A to mode 0 */
 outportb(port_a, 0x00);                /* set all display data lines to 0 */
 outportb(port_b, 0x00);                /* set all display address lines to 0 */
 outportb(port_c, 0x1F);                /* disable all display control lines */
 outportb(port_b, 0x30);                /* access display control word register */
 outportb(port_c, 0x05);                /* initialize lines to write to display */
 outportb(port_a, 0x00);                /* set display brightness to max. */
 outportb(port_c, 0x1F);                /* disable display write lines */
 outportb(port_b, 0x3D);                /* select character location */
 outportb(port_c, 0x05);                /* initialize lines to write to display */
 outportb(port_a, 0x41);                /* write character "A" to display */
 outportb(port_c, 0x1F);                /* disable display write lines */
 delay(500);                            /* a slight delay . . . */
 outportb(port_b, 0x30);                /* access display control word register */
 outportb(port_c, 0x05);                /* initialize lines to write to display */
 outportb(port_a, 0x06);                /* set display brightness to min. */
 outportb(port_c, 0x1F);                /* disable display write lines */
}
```

LISTING 5

```
outportb(port_b, 0x30);     /* access display Control Word Register */
outportb(port_c, 0x05);     /* initialize lines to write to display */
outportb(port_a, 0x10);     /* Blink entire display */
outportb(port_c, 0x1F);     /* disable display write lines */
```

```
outportb(port—b, 0x3D)
```

That line sets the display's $\overline{FL}$ line and address lines A4 and A3 to 1, while simultaneously setting address lines A2 to A0 to binary 101, which define the character location.

These lines are controlled by the 8255A's port B: For example, $\overline{FL}$ is connected to output PB5, and A0 is connected to output PB0. To obtain the logic levels given in Instruction 1, a binary 111101 (equal to hex 3D) must be sent to this port. ($\overline{FL}$ is the most significant bit and A0 is the least significant bit.)

To write to the display, refer to Fig. 5-b and set the $\overline{RST}$ and $\overline{RD}$ lines to 1, and the $\overline{CE}$ and $\overline{WR}$ lines to 0. These display input lines are controlled by port C of the 8255A. Consequently, the instruction:

```
outportb(port—c, 0x05)
```

initializes the lines required to write to the display.

Binary output 01000001 (equivalent to letter A and equal to 81H) can be sent to port A lines PA7 to PA0 of the 8255A. This value is sent to display data inputs D7 to D0. The most significant bit in binary 01000001 corresponds to D7. This enables the on-board ASCII decoder, and D6 to D0 introduce the data to be decoded. Thus the instruction:

```
outportb(port—a, 0x41)
```

writes the character A to the display.

When the source code line has been executed, the letter A will be visible in the third character position from the right. Because writing to the display is finished, the $\overline{CE}$ and $\overline{WR}$ lines can now be disabled by the code instruction:

```
outportb(port—c, 0x1F)
```

Control word register

The control word register is an eight-bit register that allows the user to adjust the display brightness, flash individual characters, blink, self-test, or clear the display. Each of these functions is independent of the others. Only brightness, blinking, and flashing RAM control will be discussed here. (The display's data sheet 5091-4950E explains the self-test and clear functions.)

Refer to Fig. 6. To set the display's brightness level, access the display control word register by setting display lines $\overline{FL}$ and A4 to 1, and A3 to 0. (The logic levels of A2 to A0 are immaterial.). When the control word register has been accessed, the brightness level can be selected.

Seven brightness levels can be selected. Set display inputs D2 to D0 to binary 000 (after toggling the display's $\overline{WR}$ and $\overline{CE}$ to 0) to select a maximum brightness level. Set display inputs D2 to D0 to binary 110 for minimum brightness. (If D2 to D0 are set to binary 111, the display will go blank). Set display inputs D7 to D3 to 0; as shown in Fig. 6.

The last four lines of Listing 2 demonstrates how the display's brightness level is selected. The first of those lines defines the logic levels for accessing the display's control word register, and sends those levels to the appropriate port. Next, the display $\overline{WR}$ and $\overline{CE}$ lines are initialized, and the third line introduces the selected brightness level. If the brightness level is to be set at its minimum value, send 000010 (equal to 6H) to port A. When the display write operation is completed, the corresponding lines are disabled.

The flashing RAM

The 1 × 8 flashing RAM stores data for flashing the display to call attention to it. This data determines the display positions that will flash on and off—one bit is assigned to each of the eight characters. The flash function differs from the blinking function, which causes the entire display to blink on and off.

To store data in a specific location in the flash RAM, access it with a specific flash RAM address, as was done with the character RAM address. First, however, clear the flash RAM of all extraneous data with the control word register.

When the display flash RAM is cleared, the character RAM is also cleared, thus clearing all display characters. Refer to Fig. 7-a and Listing 3. The flash and character RAMs are cleared whenever the control word register is accessed and display input D7 is set to 1 (hex 80H equals binary 10000000). When the flash RAM has been cleared, store the display digit location to be flashed in the flash RAM.

If you want to flash the second display digit, counting from the left flash; that location would be 001 in binary. To store that digit location, access the flash RAM first by setting display line $\overline{FL}$ to 0 and display address lines A2 to A0 to the logic levels that correspond to digit location 001. Ignore display address lines A4 and A3 because they do not affect the flash RAM location.

Refer to Fig. 7-b and again to Listing 3. Initialize the write to the display lines, and then store the digit location to be flashed in the flash RAM. To store a flashing digit location, set D0 to 1. If D0 is set to 0, the flash function for that location is disabled. Ignore data lines D7 to D1. When the display character location to be flashed is stored in the flash RAM, a character can be written to that stored location and then flashed by enabling the flash function.

Refer to the last line of Listing 4. To enable the flash function, first access the control word register, then toggle $\overline{WR}$ and $\overline{CE}$ lines to 0, and set display data line D3 to 1. When D3 is set to 1, the contents of the flash RAM are checked. For each stored location containing a 1, the associated digit will flash at a rate of about 2 Hz. If D3 is set to 0, the flash function is disabled at that location.

Refer to listing 5. To cause the display to blink, clear the flash and character RAMs, as was previously described, and write the message to the display. Next, access the control word register, and set display data line D4 to 1. Now the entire display will start blinking.

UDC RAM and address register

The user-defined character RAM (UDC RAM) stores the dot pattern for custom characters. The user-defined character address register (UDC address register) is an eight-bit wide register that provides the address to the UDC RAM when the user is writing or reading a custom character.

User-defined characters (UDC) or symbols can be created in any of the eight digit locations of the display. To create a UDC, clear the flash and character RAMs, as was explained earlier. Then define the character to be created. Assume, for example, that you want to locate the letter E at far left location 000.

To specify an entire digit location completely, You must write to the display eight times in sesession. The first cycle stores the UDC address in the eight-bit wide UDC address register. Data lines D3 to D0 are used to select one of up to 16 UDC RAM address locations, as shown in Fig. 2. The seven remaining write cycles store LED data in this selected UDC RAM location.

Data must be entered by rows, and it takes one cycle to store data for each row. Because this is a 5 × 7 dot-matrix display, each digit is displayed on an array of 35 LED dies arranged as five columns and seven rows. Figure 8 maps out the elements of the UDC character to be illuminated in terms of columns and rows.

Listing 6 shows how to access the UDC address register. First, set $\overline{FL}$ to 1, and display lines A4 to A3 to 0. (Ignore display lines A2 to A0). Toggle $\overline{WR}$ and $\overline{CE}$ to 0, and use data lines D3 to D0 to select any of the 16 UDC locations given in Fig. 2.

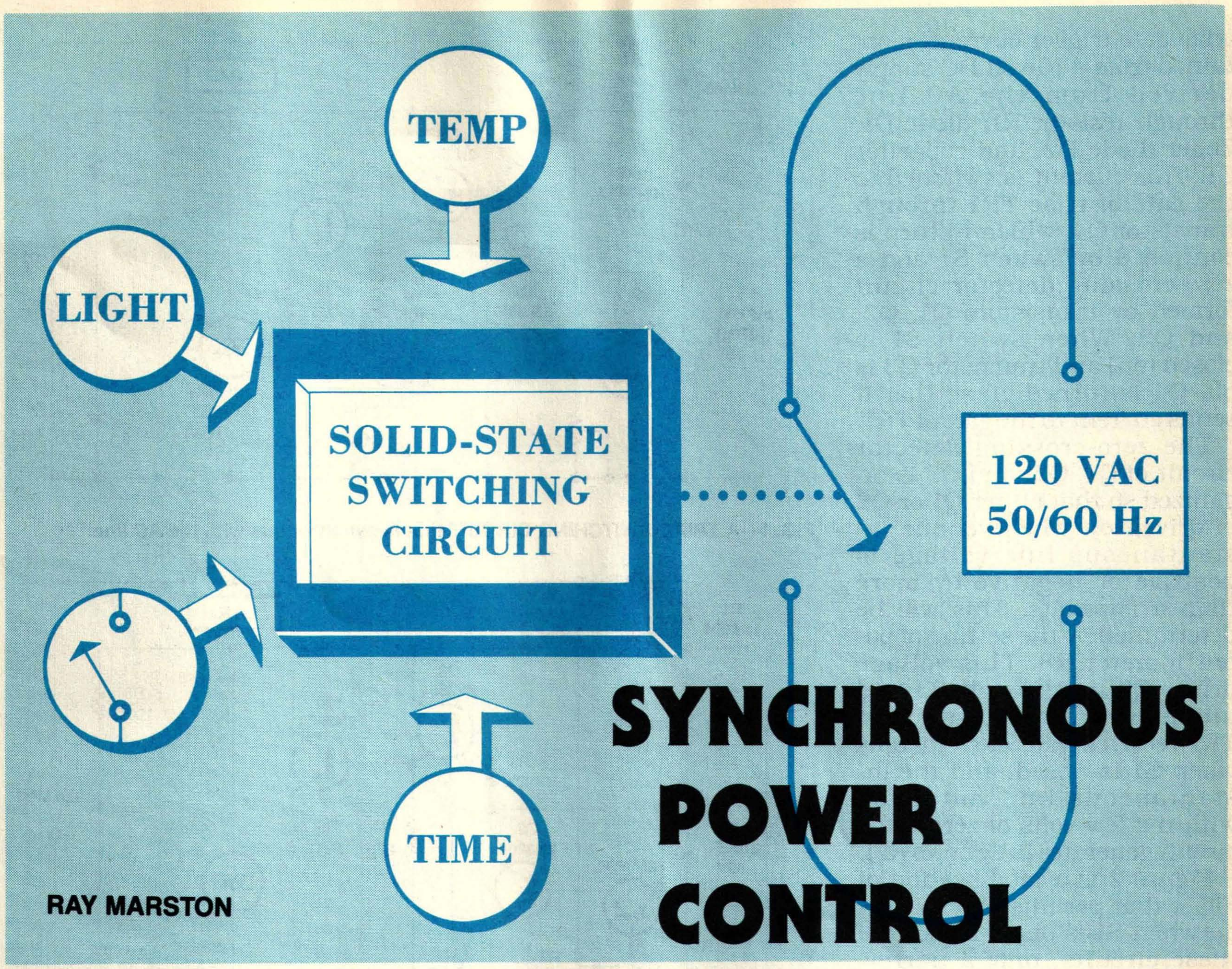
LISTING 6

```
/*
 *
 * This code it writes an "E" to the first HDSP-21XX
 * location using the display UDC mode.
 */
#include <stdio.h>              /* header files */
#include <dos.h>

#define BASE 0x300                       /* first address in address range */
#define MODE 0x80                        /* 8255A mode control word */

int port_a=BASE,                         /* address of port A outputs PA0-PA7 */
    port_b=BASE+1,                       /* address of port B outputs PB0-PB5 */
    port_c=BASE+2,                       /* address of port C outputs PC0, PC2-
PC4 */
    mode_port=BASE+3;                    /* address of 8255A control word port */

int dot_data,
    udc_ram_addr;

  static udc_array[7] ={0x1F,0x10,0x10,0x1F,0x10,0x10,0x1F};

                  /* row1,row2,row3,row4,row5,row6,row7 */
void main(void)
{
 outportb(mode_port,MODE);           /* set 8255A to mode 0 */
 outportb(port_a, 0x00);             /* set all display data lines to 0 */
 outportb(port_b, 0x00);             /* set all display address lines to 0 */
 outportb(port_c, 0x1F);             /* disable all display control lines */
 outportb(port_b, 0x30);             /* access display control word register */
 outportb(port_c, 0x05);             /* initialize lines to write to display */
 outportb(port_a, 0x80);             /* clear flash and character RAMs */
 outportb(port_c, 0x1F);             /* disable display write lines */
 outportb(port_b, 0x20);             /* access UDC address register */
 outportb(port_c, 0x05);             /* initialize lines to write to display */
 outportb(port_a, 0x00);             /* set up UDC location */
 outportb(port_c, 0x1F);             /* disable display write lines */
 udc_ram_addr=0x28;                  /* UDC RAM address */
 for(dot_data=0; dot_data<7; dot_data++){
  outportb(port_b, udc_ram_addr);        /* access UDC RAM */
  outportb(port_c, 0x05);                /* initialize lines to write to display */
  outportb(port_a, udc_array[dot_data]); /* load UDC data */
  outportb(port_c, 0x1F);                /* disable display write lines */
  ++udc_ram_addr;                         /* go to next UDC RAM location */
 }
 outportb(port_b, 0x38);        /* access and set loc. of UDC via char. ram*/
 outportb(port_c, 0x05);        /* initialize lines to write to display */
 outportb(port_a, 0x80+0x00)    /* get UDC symbol at loc. 0000 (Table 1) */
 outportb(port_c, 0x1F);        /* disable display write lines */
}
```

To write the first UDC symbol, find the first UDC location available by setting data lines D3 to D0 binary 0000. Toggle the $\overline{CE}$ and $\overline{WR}$ lines back to 1. With the UDC RAM location defined, complete the process by loading UDC data into that UDC RAM location.

Seven port writes are required to define one UDC symbol com-

Continued on page 88



SYNCHRONOUS POWER CONTROL

RAY MARSTON

Learn about zero-voltage or synchronous AC-line power switching and control and put it to work in your own projects

THE SUBJECT OF THIS ARTICLE IS synchronous on/off power switching circuits that can switch AC power for lighting, heaters, air conditioners, motors, household appliances, and industrial and commercial equipment. Many different kinds of AC control circuits are presented including four different circuits for the control of a home electric heater. This is the third in a series of articles on power switching.

All of the circuits described here include triac drivers, and the components for all circuits were selected for operation from 120-volt, 50/60-Hz line power. The reader can select a triac with the rating and package style that best suits his application or circuit experiment requirements.

Synchronous switching

Previous articles in this series explained that a triac is a bidirectional thyristor that can be turned on to pass a load current in either direction. It acts like two inverse-parallel-connected silicon controlled rectifiers (SCR). This characteristic permits it to function in both AC and DC circuits. Triacs can be triggered (turned on and latched) either synchronously or asynchronously when across an AC line.

A suitable triac for use in building the circuits discussed in this article would have a voltage rating of least a 200-volts and an on-state (RMS) current rating of 4 to 6 amperes. A Motorola 2N6071 or equivalent will meet these requirements.

Recall that synchronous circuits *always* turn on at the same point in each AC half-cycle (usually just after the zero-crossing point). When triac turn-on occurs at zero crossing, little or no radio-frequency interference (RFI) is generated if the load is primarily resistive. By contrast, asynchronous circuits do not switch regularly at a fixed point on the AC sinewave, so they can generate a significant amount of RFI.

Figure 1 is a synchronized AC power switch that is triggered near the zero-voltage crossover points of the AC waveform. The triac gate trigger current is obtained from a 10-volt DC supply derived from the AC line through resistor R1, diode D1, Zener diode D2, and capacitor C1. This current is switched to the gate of triac TR1 through transistor Q4, which in turn is controlled by switch S1 and a zero-crossing detector circuit formed by transistors Q1, Q2, and Q3. When switch S1 is closed (on) and transistor Q3 is off, Q4 is turned on so that it sends current to the gate of TR1.

The zero-crossing detector circuit of Q1, Q2, and Q3 is organized so that either Q1 or Q2 is driven on whenever the instantaneous line voltage is positive or negative by more than a few volts. This will be determined by the setting of potentiometer R8. This voltage drives Q3 on through R3 and inhibits Q4. Consequently triac TR1 receives gate current only when S1 is closed, and the instantaneous line voltage is within a few volts of zero. This circuit generates little or no RFI.

Figure 2 is a modification of Fig. 1 that permits TR1 to turn on when S1 is open. In both of these circuits, only a narrow current pulse is sent to the gate of triac TR1. As a result, current drain on the supply is only about 1 milliampere. Switch S1 can be replaced by a combination sensor and switch that will sense changes in temperature or other physical variables, and switch the power to appliances and other AC-powered products automatically.

If the switch is replaced by an optocoupler,as will be discussed later, the control circuit will be electrically isolated from any of the external circuitry and the threat of electrical shock for the user in the event of a circuit fault will be eliminated.

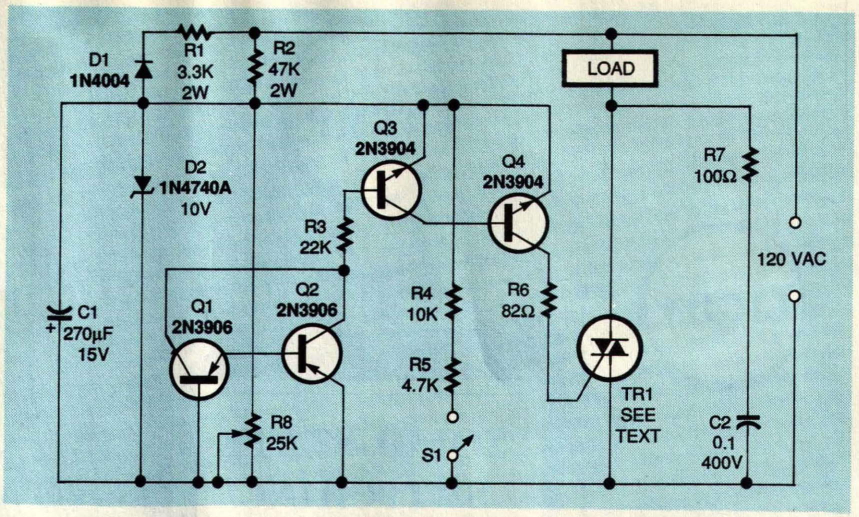

R1
3.3K
2W
R2
47K
2W
D1
1N4004
LOAD
Q3
2N3904
D2
1N4740A
10V
Q4
2N3904
R7
100Ω
R3
22K
120 VAC
C1
270µF
15V
Q1
2N3906
Q2
2N3906
R4
10K
R6
82Ω
R5
4.7K
R8
25K
S1
TR1
SEE
TEXT
C2
0.1
400V

FIG. 1—A TRIAC SWITCHING CIRCUIT that is synchronous with the AC line.

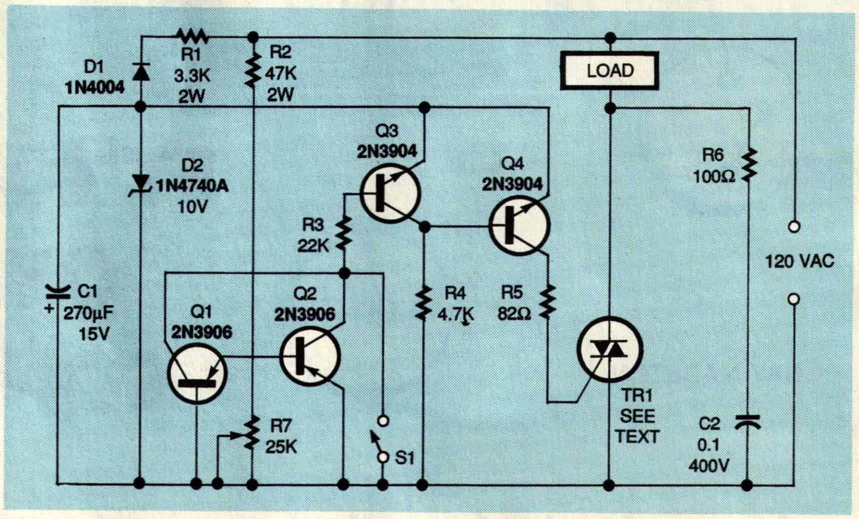

R1
3.3K
2W
R2
47K
2W
D1
1N4004
LOAD
Q3
2N3904
D2
1N4740A
10V
Q4
2N3904
R6
100Ω
R3
22K
120 VAC
C1
270µF
15V
Q1
2N3906
Q2
2N3906
R4
4.7K
R5
82Ω
R7
25K
S1
TR1
SEE
TEXT
C2
0.1
400V

FIG. 2—A MODIFIED VERSION of the synchronous AC line switch.

Zero-voltage switching ICs

The CA3059 and the CA3079 are monolithic silicon IC zero-voltage switches capable of controlling thyristors in different applications. Originally developed by RCA, they are now made by Harris Semiconductor, These ICs are useful in AC-power switching for AC input voltages from 24 to 277 volts at 50/60 and 400 Hz. Each includes four functional blocks:

1. *Limiter power supply* that permits it to operate directly from the AC line.
2. *Differential on/off sensing amplifier* that tests the condition of external sensors or command signals.
3. *Zero-crossing detector* that synchronizes the output pulses of the circuit when the AC cycle is at the zero voltage point. This eliminates radio-frequency interference (RFI) when the load is resistive.
4. *Triac gating circuit* that provides high-current pulses to the gate of the power-controlling thyristor.

Figure 3 is a pinout diagram for the CA3059. It is the same as the pinout diagram for the CA3079, except that pin 14 of that IC is not to be used. The CA3079 is the same as the CA3079 except for differences in input current rating and sensor range, and it is rated for a maximum DC supply voltage of

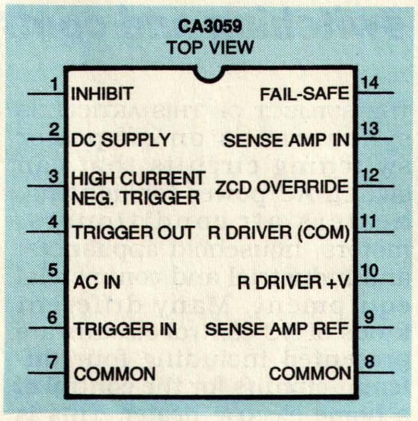

CA3059
TOP VIEW
1 INHIBIT
2 DC SUPPLY
3 HIGH CURRENT NEG. TRIGGER
4 TRIGGER OUT
5 AC IN
6 TRIGGER IN
7 COMMON
14 FAIL-SAFE
13 SENSE AMP IN
12 ZCD OVERRIDE
11 R DRIVER (COM)
10 R DRIVER +V
9 SENSE AMP REF
8 COMMON

FIG. 3—PINOUT DIAGRAM for the CA3059 zero-voltage thyristor driver integrated circuit.

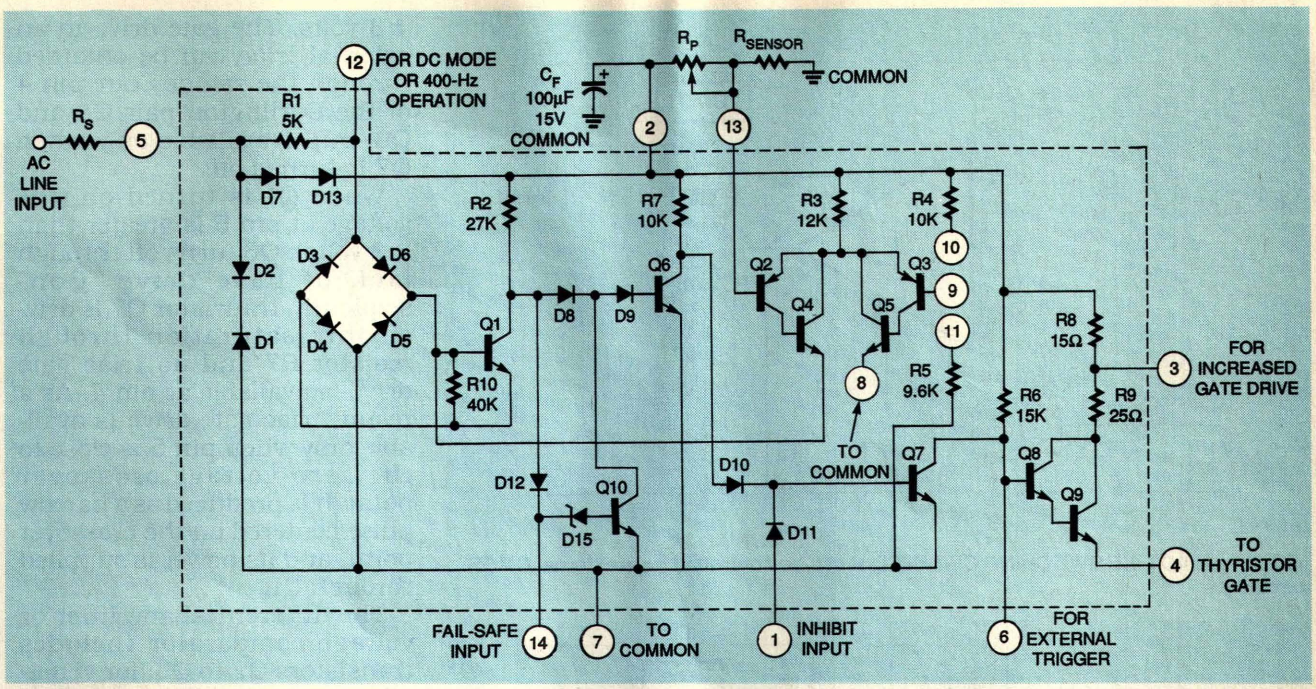

RP
RSENSOR
COMMON
12
FOR DC MODE
OR 400-Hz
OPERATION
CF
100µF
15V
COMMON
2
13
RS
5
AC
LINE
INPUT
R1
5K
D7
D13
D2
D1
D3
D6
D4
D5
R2
27K
Q1
R10
40K
D8
D9
Q6
R7
10K
Q2
Q4
Q5
Q3
R3
12K
R4
10K
10
9
11
8
TO
COMMON
R5
9.6K
R8
15Ω
3
FOR
INCREASED
GATE DRIVE
R6
15K
R9
25Ω
Q7
Q8
Q9
4
TO
THYRISTOR
GATE
D10
D11
D12
D15
Q10
FAIL-SAFE
INPUT
14
7
TO
COMMON
1
INHIBIT
INPUT
6
FOR
EXTERNAL
TRIGGER

FIG. 4—INTERNAL CIRCUITRY of a CA3059 zero-voltage thyristor driver IC.

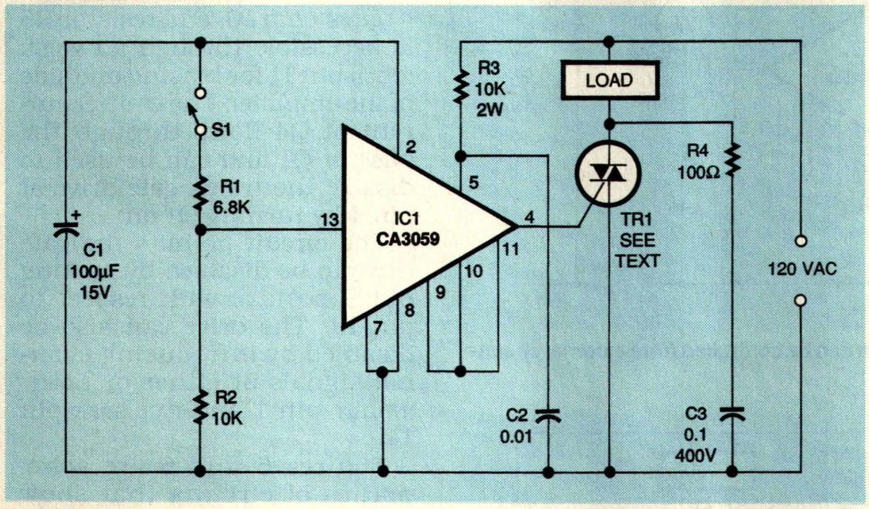

S1
R1
6.8K
C1
100µF
15V
R2
10K
IC1
CA3059
2
5
13
4
11
10
9
8
7
R3
10K
2W
LOAD
TR1
SEE
TEXT
R4
100Ω
120 VAC
C2
0.01
C3
0.1
400V

FIG. 5—A ZERO VOLTAGE TRIAC driver AC line switch based on the CA3059.

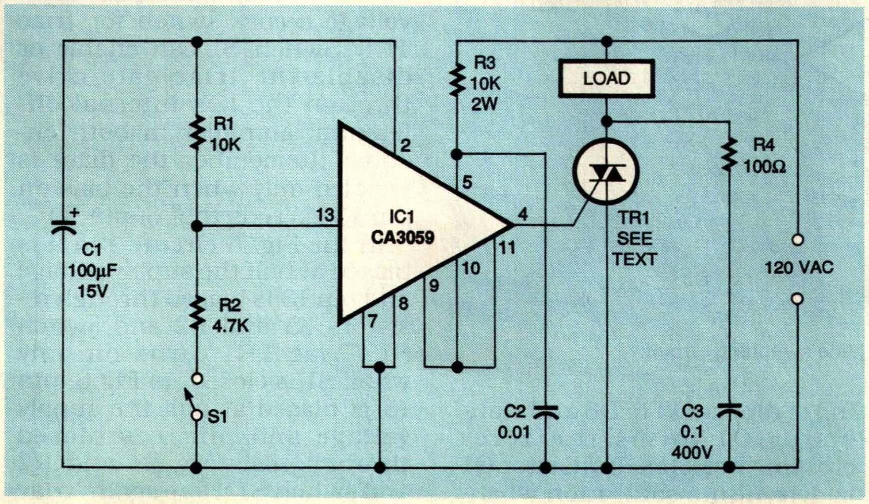

R1
10K
C1
100µF
15V
R2
4.7K
S1
IC1
CA3059
2
5
13
4
11
10
9
8
7
R3
10K
2W
LOAD
TR1
SEE
TEXT
R4
100Ω
120 VAC
C2
0.01
C3
0.1
400V

FIG. 6—AN ALTERNATIVE CIRCUIT for a CA3059-based AC line switching circuit.

10 volts rather than the CA3059's 14 volts.

The CA3059 has a built-in protection circuit that can be actuated to remove the drive from the triac if the sensor open- or short-circuits. The triac can be inhibited by the action of an internal diode gate connected to pin 1. Moreover, high-power DC comparator operation is provided by the overriding the zero-crossing detector. This is accomplished by connecting ZCD OVERRIDE pin12 to COMMON pin 7. Gate current to the triac is continuous when SENSE AMP IN pin 13 is positive with respect to SENSE AMP REF pin 9.

Figure 4 is the internal schematic diagram for both the CA3059 and CA3079. Also included in the schematic are some important external components. The AC line is connected across AC IN pin 5 and pin 7 through limiting resistor R1. Diodes D1 and D2 act as back-to-back Zener diodes to limit the voltage on AC IN pin 5 to ±8 volts.

On positive half cycles, diodes D7 and D13 rectify this voltage and generate 6.5 volts across the 100 µF electrolytic capacitor C_F connected to DC SUPPLY pin 2. This capacitor stores enough energy to drive all of the IC's internal circuitry and still provide

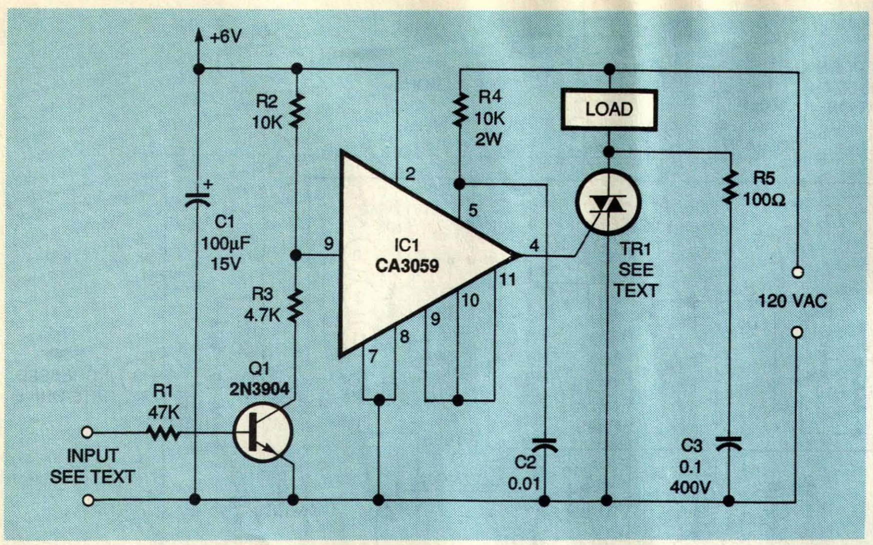

+6V
R2
10K
R4
10K
2W
LOAD
2
5
C1
100µF
15V
9
IC1
CA3059
4
TR1
SEE
TEXT
R5
100Ω
11
10
9
8
7
R3
4.7K
120 VAC
Q1
2N3904
R1
47K
INPUT
SEE TEXT
C2
0.01
C3
0.1
400V

FIG. 7—**AN AC LINE SWITCHING CIRCUIT** that can be controlled from external CMOS circuitry.

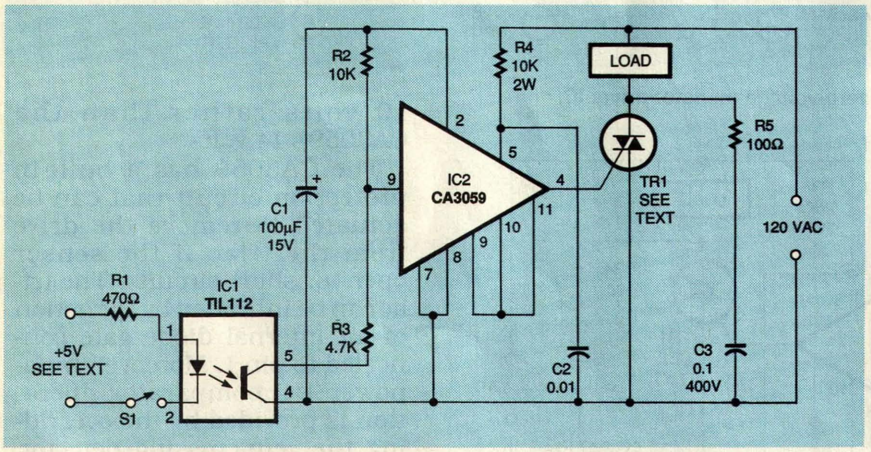

R2
10K
R4
10K
2W
LOAD
2
5
9
C1
100µF
15V
IC2
CA3059
4
TR1
SEE
TEXT
R5
100Ω
11
10
9
8
7
120 VAC
R1
470Ω
IC1
TIL112
1
5
4
2
+5V
SEE TEXT
S1
R3
4.7K
C2
0.01
C3
0.1
400V

FIG. 8—**AN AC LINE SWITCHING CIRCUIT** that can be controlled from external circuitry through an isolating optocoupler.

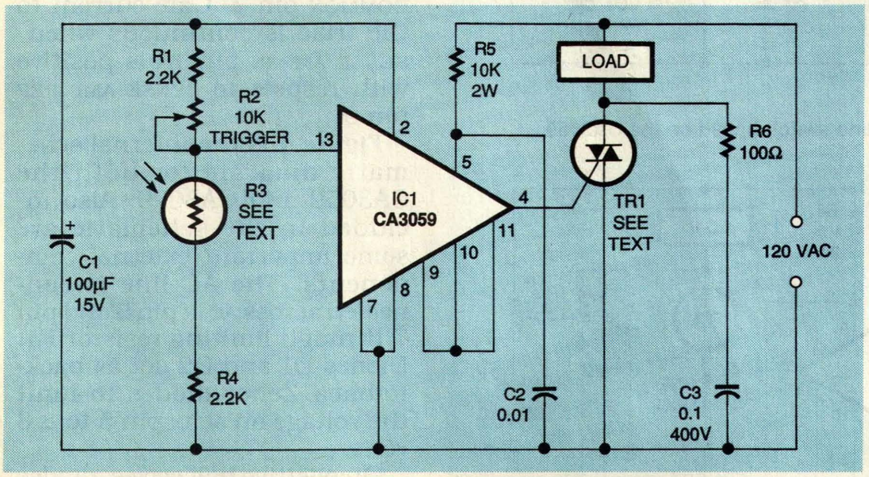

R1
2.2K
R2
10K
TRIGGER
13
R5
10K
2W
LOAD
2
5
R3
SEE
TEXT
IC1
CA3059
4
TR1
SEE
TEXT
R6
100Ω
C1
100µF
15V
11
10
9
8
7
120 VAC
R4
2.2K
C2
0.01
C3
0.1
400V

FIG. 9—**A LIGHT-ACTIVATED** zero-voltage AC line switching circuit.

adequate triac gate drive. A current of a few milliamperes is also available for powering external circuitry.

The bridge rectifier consisting of diodes D3 to D6 and transistor Q1 forms the zero-crossing detector. Transistor Q1 is driven into saturation whenever the voltage on pin 5 exceeds ±3 volts. The gate drive to an external triac can be obtained through the TRIGGER OUT pin 4 of the Darlington pair Q8 and Q9, but is available only when Q7 is turned off.

When Q1 is turned on (the voltage at pin 5 is greater than ±3 volts), Q6 turns off through lack of base drive. Consequently, transistor Q7 is driven into saturation through resistor R7 and no triac gate drive is available at pin 4. As a result, triac gate drive is available only when pin 5 is close to the zero-voltage crossover point. It is produced as a narrow pulse centered on the crossover point, and its power is supplied through C1.

The differential amplifier or voltage comparator includes transistors Q2 to Q5, for general purpose applications. Resistor R4 is accessible through R DRIVER pin 10, and resistor R5 is accessible through R DRIVER (COM) pin 11 for biasing one side of the amplifier. The emitter current of Q4 flows through the base of Q1 and can be used to disable the triac's gate drive at pin 4 by turning Q1 on.

The circuit permits the gate drive to be disabled by making pin 9 positive with respect to pin 13. The drive can also be disabled by introducing external signals at either or both INHIBIT pin 1 and FAIL-SAFE pin 14.

Figures 5 and 6 are schematics of circuits that show how the CA3059 can function as a manually controlled, zero-voltage ON/OFF switch for triac TR1. Switch S1 can enable or disable the triac gate drive through the IC's internal differential amplifier in both circuits. (Remember the drive is enabled only when the bias on pin 13 exceeds that of pin 9.)

In the Fig. 5 circuit, pin 9 is biased at half the supply voltage and pin 13 is biased through resistors R1 and R2 and switch S1. Triac TR1 turns on only when S1 is closed. In Fig.6, pin 13 is biased at half the supply voltage and pin 9 is biased through resistors R1 and R2 and switch S1. Here again, triac TR1 turns on only when S1 is closed. Switch S1 switches voltage with a maximum value of 6 volts and current that has a maximum value of approximately 1 milliampere.

In both of these schematics, capacitor C2 applies a slight phase delay to the AC IN pin 5 of the CA3509. This shifts the gate pulse phase so that the gate pulses occur after rather than straddle the zero-voltage crossover point. The triac in Fig. 6 can be turned on by pulling R2 low or it can be turned off by letting R3 float.

Figures 7 and 8 are circuits that demonstrate how this relationship can be applied to extend the versatility of the basic circuit. In Fig. 7, the triac can be turned on and off by transistor Q1, which in turn can be controlled by external CMOS circuitry (such as one-shot or astable multivibrator). These can be powered from the 6-volt supply at DC SUPPLY pin 2.of IC1.

The circuit in Fig. 8 can be turned on and off by fully isolated external circuitry through an optocoupler. It needs an input of only three or four volts to turn the triac TR1 on. A simple optocoupler or optoisolator such as the TIL112 made by Motorola and others will work here.

Figures 9 and 10 show several of ways of organizing the CA3059 so that the triac functions as a light-sensitive (or dark-operated) power switch. In these two circuits, the CA3059's built-in precision voltage comparator turns the triac on or off when one of the comparator input voltages goes above or below the other. A stock cadmium-sulfide (CdS) photoresistor will work here.

Figure 9 is a dark (or lack of light)-activated power switch. Pin 9 iof IC1 is connected to the half voltage supply , and pin 13 is controlled through resistor R1, potentiometer photoconductive cell (or photoresistor) R3, and resistor R4 acting together as a voltage divider. Under bright light the photoconductive cell has a low resistance, so the voltage on pin 13 is below that on pin 9 and the triac is disabled.

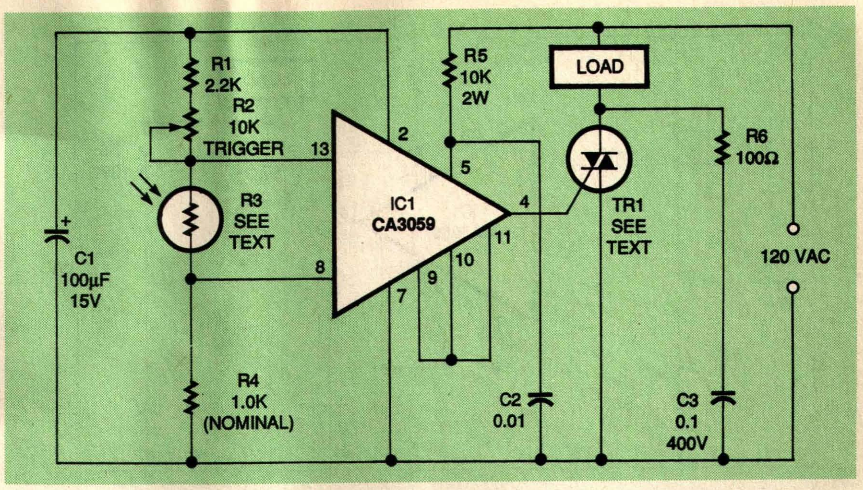

R1
2.2K
R2
10K
TRIGGER
13
R3
SEE
TEXT
+
C1
100µF
15V
IC1
CA3059
2
5
4
11
10
9
8
7
R5
10K
2W
LOAD
R6
100Ω
TR1
SEE
TEXT
120 VAC
R4
1.0K
(NOMINAL)
C2
0.01
C3
0.1
400V

FIG. 10—A LIGHT-ACTIVATED zero-voltage AC line switching circuit with hysteresis that delays its response.

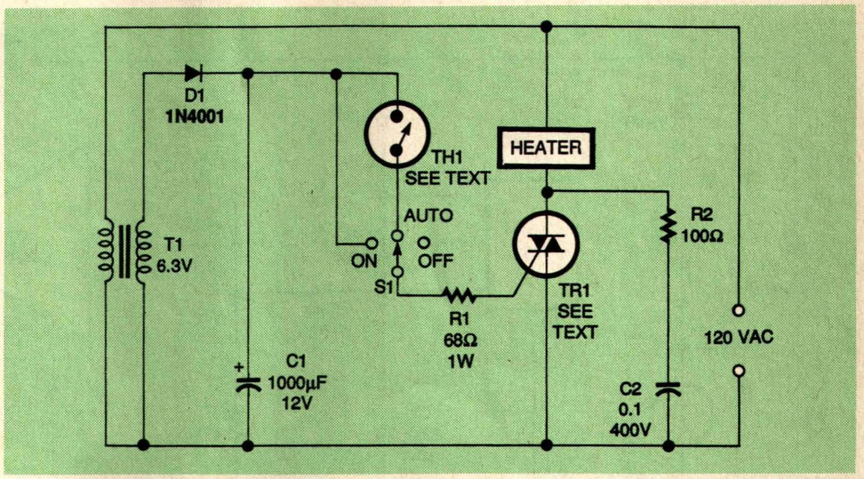

D1
1N4001
TH1
SEE TEXT
HEATER
AUTO
ON
OFF
S1
T1
6.3V
R1
68Ω
1W
TR1
SEE
TEXT
R2
100Ω
120 VAC
+
C1
1000µF
12V
C2
0.1
400V

FIG. 11—AN ELECTRIC HEATER CONTROL circuit that offers thermostat-switched DC gating.

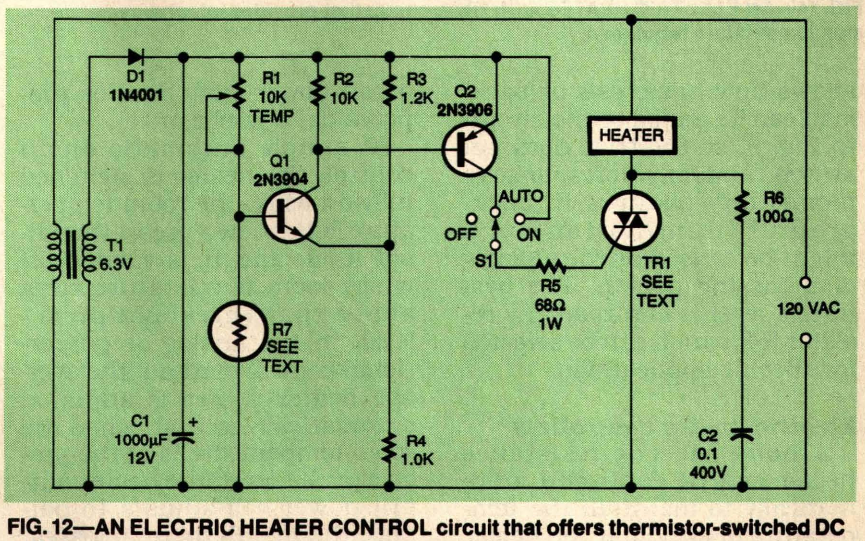

D1
1N4001
R1
10K
TEMP
R2
10K
R3
1.2K
Q2
2N3906
HEATER
Q1
2N3904
AUTO
OFF
ON
S1
T1
6.3V
R5
68Ω
1W
TR1
SEE
TEXT
R6
100Ω
120 VAC
R7
SEE
TEXT
C1
1000µF
12V
+
R4
1.0K
C2
0.1
400V

FIG. 12—AN ELECTRIC HEATER CONTROL circuit that offers thermistor-switched DC gating.

Under dark conditions the photoconductive cell has a high resistance. Therefore, pin 13 has a higher voltage than pin 9. This triggers the triac so AC power is fed to the load. The threshold switching level of the circuit can be preset with trimmer potentiometer R2.

The schematic of Fig. 10

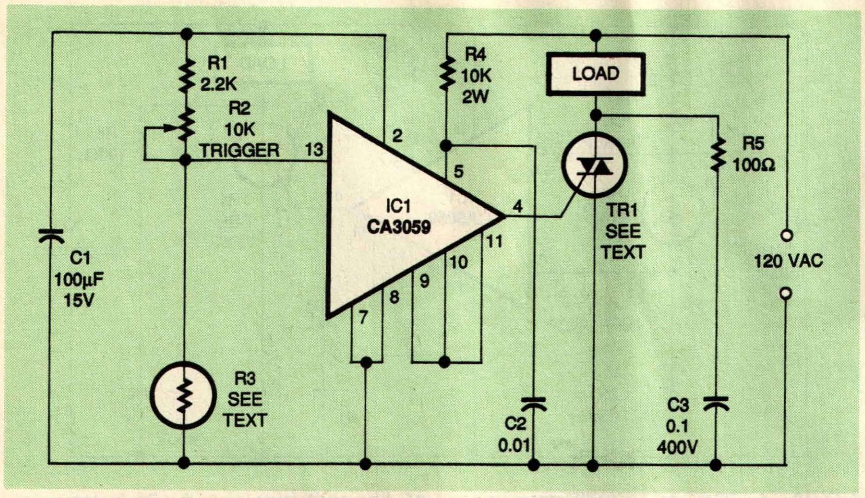


FIG. 13—AN ELECTRIC HEATER CONTROL circuit with thermistor-regulated zero-voltage switching.

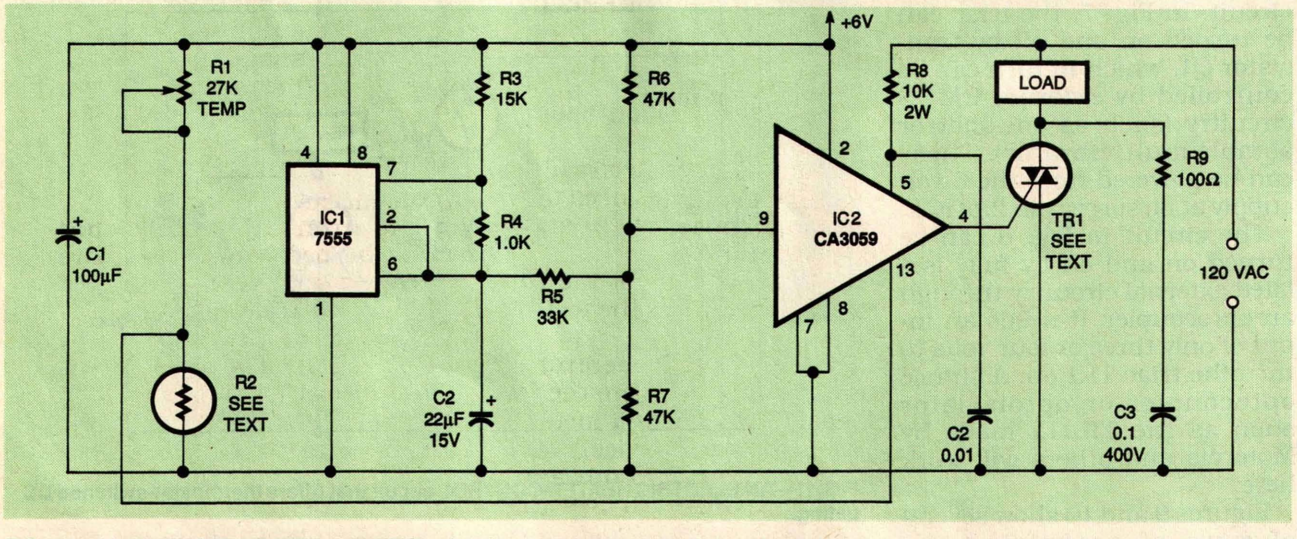


FIG. 14—AN ELECTRIC HEATER CONTROL circuit that provides integral-cycle precision temperature regulation.

shows how *hysteresis* or backlash can be added to the circuit in Fig. 9, so the triac does not switch randomly in response to momentary changes in background illumination such might be caused by the shadow of a passing person. The hysteresis level is controlled by resistor R4, which can be selected for specific applications.

Electric heater controllers

A home electric-resistance heater can be controlled automatically to maintain the temperature of a room if the heater is switched on and off by a triac with a thermistor or thermostat acting as the feedback control element in a closed-loop system. Two different control methods are possible: simple automatic on/off power switching or proportional power control.

In simple automatic on/off control, the heater is switched fully on when the room temperature falls below a preset threshold level, and it is turned off when room temperature rises above that threshold preset level. In the analog or proportional control method, the average heater power is adjusted automatically so that, when the room temperature is at the precise preset level, the heater output power self-adjusts to balance the room's thermal losses.

Because of the high power requirements of electric heaters, attention must be given to minimizing radio-frequency interference in the design of triac-control circuits. This can be done by continuous DC gating of the triac, or by synchronously pulsed gating. The advantage of DC gating is that, in basic on/off switching, the triac generates no RFI in normal (on) operating conditions. However, the disadvantage is that the triac can generate a powerful RFI spike as it is switched from the off to the on state.

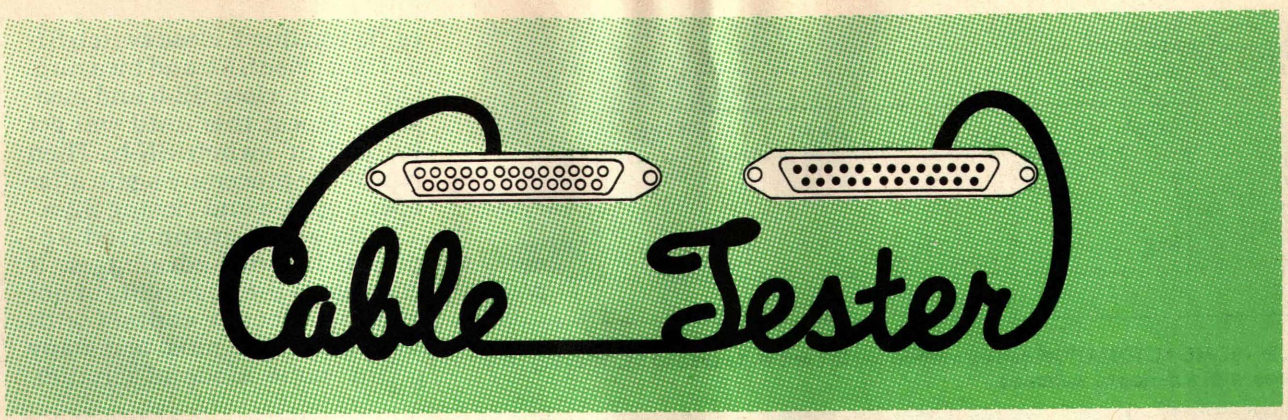
The advantage of synchronous gating is that no high-level RFI is generated as the triac transitions. The disadvantage is that the triac generates low level RFI continuously when in its on state.

DC-gated circuits

Figures 11 and 12 are schematics for DC-gated heater control circuits. The DC supply is obtained from the interaction of transformer T1, diode D1 and capacitor C1. In the Fig. 11 schematic, the heater can be automatically controlled by the thermostat.

By contrast, the circuit in Fig. 12 is controlled by negative temperature coefficient (NTC) thermistor TH1 and transistors Q1 and Q2. Potentiometer R1, thermistor TH1, and resistors R3 and R4 form a heat-sensitive bridge, and transistor Q1 detects bridge balance. Potentiometer R1 can be adjusted so that Q1 just starts to conduct as the room temperature falls to the preset level. Below that level, transistors Q1 and Q2 and triac

Continued on page 74



Build PcSuperCon, a low-cost multipath continuity tester.

JAMES J. BARBARELLO

TESTING MULTICONDUCTOR CABLES for continuity is a time-consuming task. Unless you can afford expensive, specialized equipment fopr doing it, it is also difficult to do it without making errors.

A number of years back, I was at a contractor's plant where two technicians were testing cables. Each held a probe connected to an ohmmeter. One technician would touch a pin on a connector attached to one end of a long cable assembly and yell something like "C-24." The other would move his probe to his connector's pin C-24 to check for continuity, and then he'd check every other pin to make sure that there weren't any short circuits. This continued for what seemed like forever, and I remember thinking "That's got to be the most boring task in the world!". Unfortunately, that wasn't an isolated event—I saw this scenario played out again and again in different plants.

When there are many connections in a cable, PC board, or other device, you must check to make sure all the intended connections are corect, and that no unintended connections (short circuits) are present. This kind of repetitive task doesn't have to tie up two technicians—it's just right for a personal computer.

Continuity testing

The theory behind continuity testing is pretty simple if you understand these terms:

- Line—A connection between two points.
- Test Signal—An electrical signal (AC or DC) that's used to determine if continuity exists on the line.
- Input—That end of the connection path where the test signal is inserted.
- Output—The other end of the connection path where the test signal is sensed (by a meter or other measuring device).
- Short Circuit—An unwanted connection between two conductors.
- Open Circuit—The absence of an intended connection in a conductor.

Figure 1 shows how continuity is tested manually. A test signal is provided at the input of one conductor. Each of the outputs is then checked for the presence or absence of the test signal, and the results are recorded; the signal should appear at the output of the input line, and it should not be present at any other output. The test signal is then applied to the next input and the process is repeated until all wires have been checked.

The number of tests that must be performed to ensure that all wires are checked against all others is the permutation of the number of wires present. The permutation of a number (N) is $N+(N-1)+(N-2)+\ldots+1$. So for five wires, you must to perform $5+4+3+2+1$, or 15 tests. The number of tests needed increases very quickly as the number of wires increases. For instance, for 25 wires you must perform 325 tests.

In Figure 1, the input and output probes are moved manually from one wire to the other. The procedure can be partially automated with the setup shown in Fig. 2 in which the probes are "moved" with a series of switch-

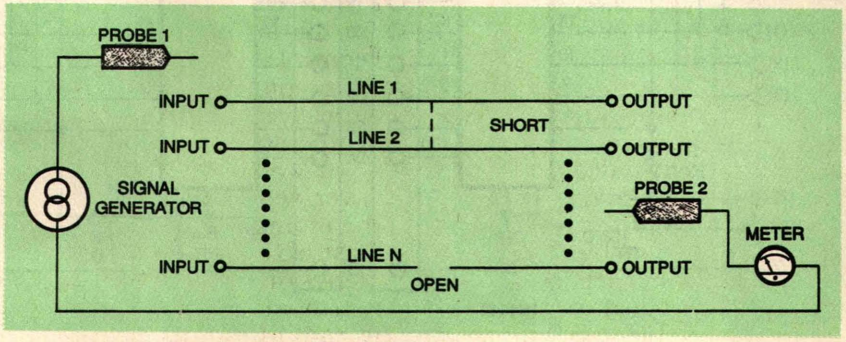


FIG. 1—**CONTINUITY IS TESTED MANUALLY** by providing a test signal at the input of one wire and then checking each of the outputs for the signal.

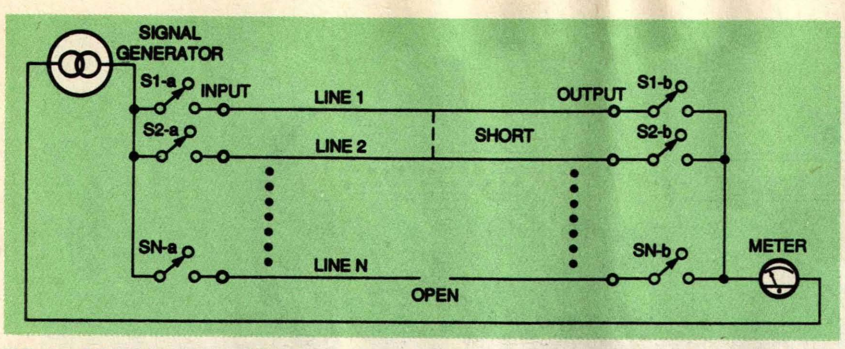

SIGNAL GENERATOR
S1-a
INPUT
LINE 1
OUTPUT
S1-b
S2-a
LINE 2
SHORT
S2-b
SN-a
LINE N
SN-b
METER
OPEN

FIG. 2—SOME AUTOMATION can be introduced to continuity testing by "moving" the probes with a series of switches.

es. To test line 1, close switch S1-a. Then close S1-b and measure. Open S1-b, close S2-b and measure. Repeat this until you get to the "Nth" switch (SN-b). Then repeat the procedure again after opening S1-a and closing S2-a.

This semi-automated approach has two advantages. It eliminates the possibility of not making effective contact with the wires. If you must test many of the same kinds of circuits,

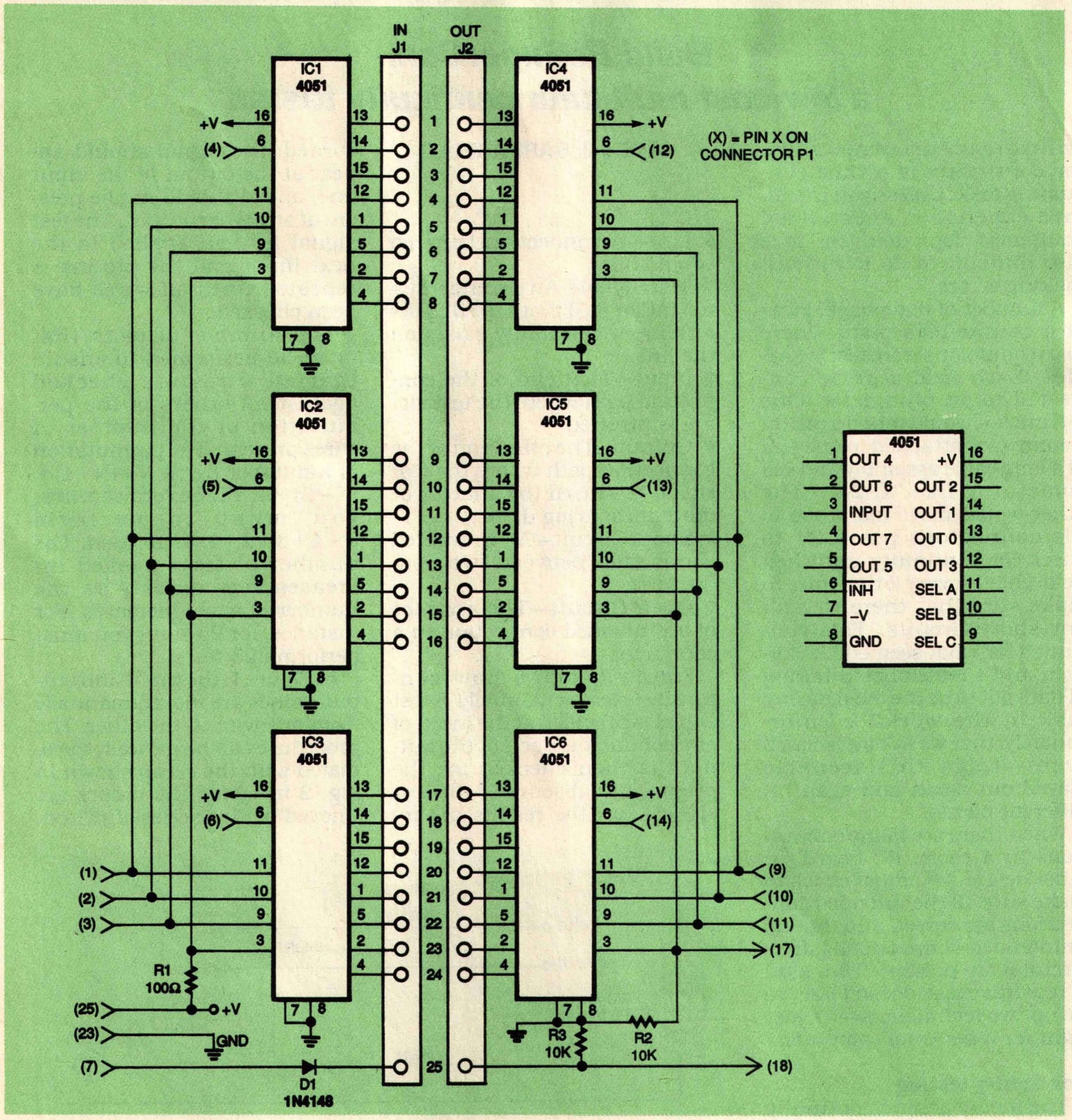

IN
J1
OUT
J2
IC1
4051
IC2
4051
IC3
4051
IC4
4051
IC5
4051
IC6
4051
+V
(4)
(5)
(6)
(12)
(13)
(14)
(X) = PIN X ON CONNECTOR P1
(1)
(2)
(3)
(9)
(10)
(11)
(17)
(25)
(23)
(7)
(18)
GND
R1
100Ω
R2
10K
R3
10K
D1
1N4148
4051
OUT 4
OUT 6
INPUT
OUT 7
OUT 5
INH
–V
GND
+V
OUT 2
OUT 1
OUT 0
OUT 3
SEL A
SEL B
SEL C

FIG. 3—TO MAKE A PC do continuity testing, the mechanical switches in Fig. 2 must be replaced with electronic ones. The 4051 contains eight electronic switches.

TABLE 1

Inhibit Input	Select Inputs			Decimal	Closed Switch (all others open)
	C	B	A		
0	0	0	0	0	S1
0	1	0	0	1	S2
0	0	1	0	2	S3
0	0	1	1	3	S4
0	1	0	0	4	S5
0	1	0	1	5	S6
0	1	1	0	6	S7
0	1	1	1	7	S8
1	X	X	X	0 - 7	All Open

PARTS LIST

R1—100 ohms, ½-watt
R2, R3—10,000 ohms, ¼-watt
D1—1N4148 or 1N914 diode
J1, J2, P1—female DB-25
IC1–IC6—CD4051B CMOS 8-channel analog multiplexer/demultiplexer, Harris or equiv.
Breadboard (Radio Shack solderless P/N 276-174, solderable P/N 276-170, or equivalent), 30 feet of 24 gauge solid wire, enclosure

Note: The following items are available from J.J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726:

- **A complete PC I/O board kit (part No. PCIO, contains PC board and all components)—$39.95**
- **Software, including complied and source code versions containing the enhancements mentioned in the article (part No. PCC-S, specify disk size)—$8.00**
- **Continutiy tester parts (part No. PCC-H, contains six 4051 ICs, R1–R3, and D1—$8.00**

Send check or money order (foreign orders please send payment in notes redeemable at a U.S. bank. Please specify part numbers. The author will answer all questions, but they must be accompanied by a self-addressed stamped return envelope.

you can wire the switches to a connector that mates with the circuit you're going to test. Then, it's a simple job to connect and disconnect the circuit. This will help to prevent mistakes and it will save some—but not enough—time.

PC continuity testing

To make a PC do all the work, the mechanical switches in Fig. 2 must be replaced with electronic ones. Then the PC must control those switches, provide the test signal, and sense the outputs. In the circuit shown in Fig. 3, the mechanical switches have been replaced by a CD4051B CMOS 8-channel analog multiplexer/demultiplexer. The 4051 contains eight electronic switches, controlled by three select input pins 9, 10, and 11. Table 1 shows how the inputs select the switches that will be activated. When any one switch is closed, the other switches are open (high impedance). When the inhibit line is high, all of the switches are open, regardless of the select inputs.

The circuit in Fig. 3 is controlled by the PC I/O interface shown in Fig. 4. The PC I/O interface is described in detail in *Radio Electronics*, July 1991, page 53. The connections marked P1 go to a female DB-25 jack that mates with the PC I/O board. Jacks J1 and J2 are the input and output connectors for the device (most likely a multiconductor cable) to be tested.

The continuity tester contains six 4051s, three on the input side and three on the output side. The common inputs of the 4051s (pin 3) are connected through current-limiting resistor R1 to +5 volts DC, obtained from pin 25 of the PC I/O card. When any of the switches in IC1, IC2, or IC3 is turned on, 5 volts is passed through that switch to J1 and the associated test line. Switch selection is controlled by pins 1, 2, and 3 of P1, which are connected to the select inputs of the 4051s. This allows the PC to select any one of the eight internal switches in IC1, IC2, or IC3.

The select inputs of all three 4051s are connected together. However, only one 4051 should be active at a time if the circuit is to work properly. Therefore, the inhibit pins (pin 6) of the 4051s are also controlled by the PC. That permits the computer to activate any one of the 4051s and inhibit the other two.

The output side of the tester is essentially the same circuit, but with one difference. The 4051 common output/input pins (pin 3) are connected together and output at P1 pin 17. That pin, an input to the PC I/O board, must see either a low (ground) or high logic level. Since the 4051s will output either a high (+5 volts) or a high-impedance open, R2 is positioned between the output and ground as a pull-down resistor to ensure that a logic low can be sensed.

The goal of the circuit design was to test cables with up to 25 conductors. However, the three 4051s can test only 24 lines. Therefore, another way to check that last line had to be found. Pin 7 of P1 can send a signal through diode D1 to J1 pin 25. On the output side, J2 pin 25 goes to P1 pin 18 which can sense the output. The diode ensures that J1 pin 25 will not pull up any line to which it is shorted and give a false indication.

Building the circuit

The circuit can be built on perfboard. Begin by soldering a 5-inch length of solid No. 24 wire to each of the 25 pins of two female DB-25 connectors (J1 and J2). Then solder a 5-inch length of No. 24 solid wire to pins 1–6, 9–14, 17, 18, 23, and 25 of a second female DB-25 connector (this will be P1).

The circuit can also be built on a solderless breadboard with at least 50 rows of connection points and two vertical rows for power distribution. The circuit should be housed in a case that provides support for the panel-mount DB-25 connectors. It is

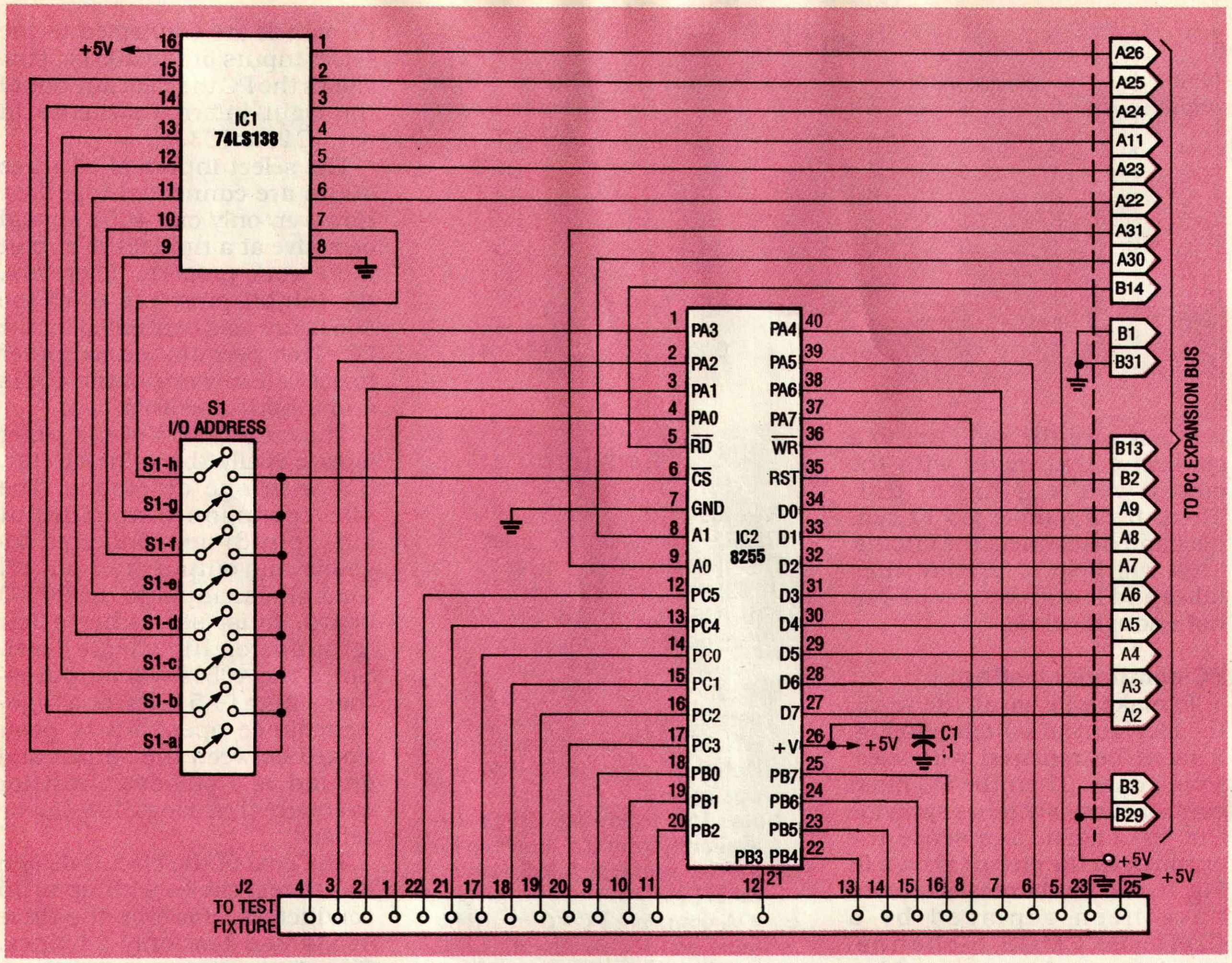

+5V
IC1
74LS138
S1
I/O ADDRESS
S1-h
S1-g
S1-f
S1-e
S1-d
S1-c
S1-b
S1-a
PA3
PA2
PA1
PA0
RD
CS
GND
A1
A0
PC5
PC4
PC0
PC1
PC2
PC3
PB0
PB1
PB2
PA4
PA5
PA6
PA7
WR
RST
D0
D1
D2
D3
D4
D5
D6
D7
+V
PB7
PB6
PB5
PB3 PB4
IC2
8255
C1
.1
+5V
J2
TO TEST
FIXTURE
A26
A25
A24
A11
A23
A22
A31
A30
B14
B1
B31
B13
B2
A9
A8
A7
A6
A5
A4
A3
A2
B3
B29
TO PC EXPANSION BUS

FIG. 4—THE PC I/O INTERFACE was described in detail in Radio Electronics, July 1991. This is the original circuit.

recommended that you mount the connectors to the case before wiring them.

Testing

To test the continuity tester your PC must be equipped with a PC I/O card, a male-to-male DB-25 cable, and a logic probe or voltmeter. Connect the cable from the PC I/O board to P1 and turn on the computer. Check for about +5 volts on pin 16 of each 4051, and ground on pins 7 and 8. Type in and run the output test program in Listing 1 using GWBASIC, BASICA or QUICKBASIC. Alternatively, the programs are available on the Gernsback BBS as part of a file called CONTTEST.TXT.

When running that program, enter each pin number (1 through 25) in turn. When "Press any key to continue..." appears, check that pin for a high signal. Then press a key and enter another pin number. Continue this until you've verified the operation of all 25 pins.

To check the output side, type in and run the input test program in Listing 2. Connect one end of a jumper wire to the junction point of pin 3 of IC1–IC3 and R1.

When you see the questions "Which J2 Pin (1..25)...," place the free end of the jumper into the pin number you want to test. While holding it there, enter that pin number. On the next line you'll see a "1" or a "0." A "1" indicates the high level was correctly sensed. Remove the jumper and enter the pin

LISTING 1

```
1  CLEAR : CLS : DEFINT A, E, I-K, O: DIM INH(4), I(625), O(625)
2  INH(1) = 48: INH(2) = 40: INH(3) = 24
3  DEFUSR = 64: ADD = 640
4  REM: Change ADD if necessary to match the address of your PcI/O Card.
5  OUT ADD + 3, 137: REM: Set PCIO For A=OUT, B=OUT, C=IN
6  REM: OUTPUT TEST (c) 1992 JJ Barbarello
7  INPUT "Which J1 Pin (1..25)..."; WHICH
8  IF WHICH > 0 AND WHICH < 9 THEN IC = 1
9  IF WHICH > 8 AND WHICH < 17 THEN IC = 2
10 IF WHICH > 16 AND WHICH < 25 THEN IC = 3
11 IF WHICH = 25 THEN IC = 4
12 IMASK = WHICH - (IC - 1) * 8 - 1 + INH(IC)
13 IF WHICH = 25 THEN IMASK = 64 + 56
14 OUT ADD, IMASK
15 PRINT "Press any key to continue...";
16 A$ = INPUT$(1): PRINT : PRINT
17 IF ASC(A$) = 27 THEN END
18 GOTO 6
```

LISTING 2

```
1  CLEAR : CLS : DEFINT A, E, I-K, O: DIM INH(4), I(625), O(625)
2  INH(1) = 48: INH(2) = 40: INH(3) = 24
3  DEFUSR = 64: ADD = 640
4  REM: Change ADD if necessary to match the address of your PcI/O Card.
5  OUT ADD + 3, 137: REM: Set PCIO For A=OUT, B=OUT, C=IN
6  REM: INPUT TEST (c) 1992 JJ Barbarello
7  INPUT "Which J2 Pin (1..25)..."; WHICH
8  IF WHICH > 0 AND WHICH < 9 THEN IC = 1
9  IF WHICH > 8 AND WHICH < 17 THEN IC = 2
10 IF WHICH > 16 AND WHICH < 25 THEN IC = 3
11 IF WHICH = 25 THEN IC = 4
12 IMASK = WHICH - (IC - 1) * 8 - 1 + INH(IC)
13 IF WHICH = 25 THEN IMASK = 56: A = 2: OUT ADD, 64 + IMASK ELSE A = 1
14 OUT ADD + 1, IMASK
15 PRINT INP(ADD + 2) AND A, IMASK
16 PRINT ; "Press Any key to continue...";
17 A$ = INPUT$(1): PRINT : PRINT
18 IF ASC(A$) = 27 THEN END
19 GOTO 6
```

LISTING 3

```
1  CLEAR : CLS : DEFINT A, E, I-K, O: DIM INH(4), I(625), O(625)
2  INH(1) = 48: INH(2) = 40: INH(3) = 24
3  DEFUSR = 64: ADD = 640
4  REM: Change ADD if necessary to match the address of your PcI/O Card.
5  OUT ADD + 3, 137: REM: Set PCIO For A=OUT, B=OUT, C=IN
6  REM: BASIC TESTER (c) 1991 JJ Barbarello
7  PRINT "Press Any key to begin...";: A$ = INPUT$(1): PRINT
8  ICNT = 0
9  FOR I = 1 TO 25
10 IF I = 1 THEN IC1 = 1
11 IF I = 9 THEN IC1 = 2
12 IF I = 17 THEN IC1 = 3
13 IMASK = I - (IC1 - 1) * 8 - 1 + INH(IC1)
14 IF I = 25 THEN IMASK = 64 + 56
15 OUT ADD, IMASK
16 FOR J = I TO 25
17 IF J >= 1 THEN IC2 = 1
18 IF J >= 9 THEN IC2 = 2
19 IF J >= 17 THEN IC2 = 3
20 IMASK2 = J - (IC2 - 1) * 8 - 1 + INH(IC2)
21 IF J = 25 THEN IMASK2 = 64 + 56
22 OUT ADD + 1, IMASK2
23 ISTATUS = (INP(ADD + 2) AND 1)
24 IF ISTATUS = 1 THEN ICNT = ICNT + 1: I(ICNT) = I: O(ICNT) = J
25 IF I = 25 AND J = 25 AND (INP(ADD + 2) AND 2) = 2 THEN ICNT = ICNT + 1:
     I(ICNT) = I: O(ICNT) = J
27  NEXT J
28 NEXT I
29 FOR I = 1 TO ICNT
30 PRINT I(I); "-"; O(I), : NEXT
```

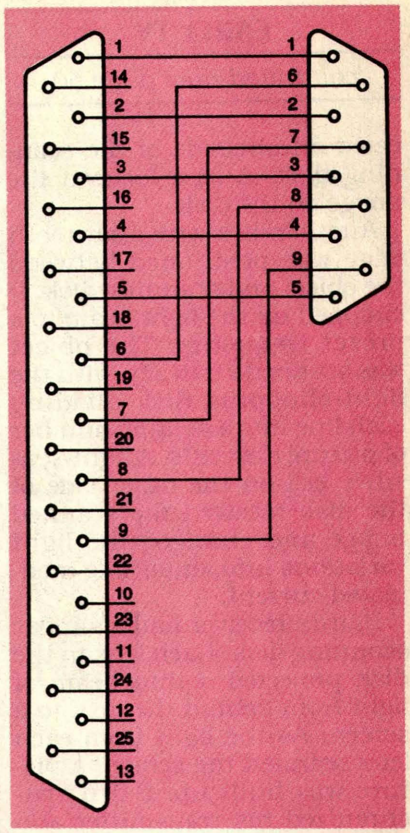


FIG. 5—TO CHECK A DB-9 CABLE, make two adapters and connect them to J1 and J2.

number again. This time you should get a "0." Follow the same procedure for all 25 pins of the connector.

Basic use

The most basic use of the tester is checking DB-25 male-to-male cables. Connect the cable to be tested between J1 and J2 and run the basic tester program in Listing 3. A typical output from the program will show the connections found. Also, if the circuit has a short, say between pins 2 and 3, you'll see two additional entries, 2 - 3 and 3 - 2. If the circuit has an open, that pin will not be shown as a connection (for instance, there would be no 5 - 5 if there were an open on line 5). The complete test of all 625 possibilities will take only a few seconds.

Enhancements

With the basic program, you must determine which lines were connected, which are missing, and which are shorted by visually scanning the list. This is OK for a one-time check, but inefficient for repetitive testing of the same kind of circuit. One enhancement would be to have a data file that defines the desired connections and display PASS or FAIL with only the open or short circuits listed.

To check cables other than DB-25 male-to-male, you must make appropriate adapters. For example, to check a DB-9 cable, you would make two adapters as shown in Fig. 5. Connect the adapters to J1 and J2, and the DB-9 cable to the adapters.

You can also test bare PC boards. Here you create a "bed of nails," which is a base with pins that contact the PC board in specific spots. The PC board is placed on the base and the spring-loaded pins (called "pogo" pins) make contact with the test points on the board. You could then check to see if specific points are connected, open, or shorted. If more than 25 points have to be tested, you could make multiple bases for additional tests.

Attenuation can also be tested. For example, if the cable must have less than 10 ohms resistance, replace R1 and R2 with potentiometers. If you then temporarily place a 10 ohm resistor between pin 1 of J1 and J2, and run the input test program in Listing 2, you can adjust the voltage level so that the indication changes from a "1" to a "0." Then back off the potentiometer so the indication changes back to a "1." Now, any device with a resistance higher than 10 ohms will cause less voltage to be dropped across R2 and give a "0" indication. Ω

EARLY TV

continued from page 50

cated on one side of the scanning disk. A lens focused the image on the disk.

Another disk with a sawtooth edge was positioned between the object and scanning disk. It chopped up the light beam to a preset frequency. The object was scanned vertically, with the light-chopping disk dividing each line into a definite number of picture elements. A light-sensitive cell on the other side of the disk received the scanned image and changed the light variations into amplitude modulated current.

Baird's receiver had a similar scanning disk. Each lens in the disk projected a thin beam of light from behind the disk to a screen. As the light from each lens scanned the screen, a picture was built up. Baird synchronized his transmitter and receiver disks by connecting an AC generator to the transmission disk's drive motor and a synchronous motor was connected to the receiving disk.

The first television drama was broadcast by station WGY in 1928, and the first television images were screen-projected in a theater in Schenectady, New York, in 1930. Both systems were mechanically scanned.

Electronic scanning

Television as we know it today became a reality only after the invention of the iconsosope or camera tube by Vladimir Zworykin, a Russian emigre to the U.S. The iconoscope, when paired with the receiving picture tube, made electronic scanning possible. Both the iconoscope and the picture tube were developed from the earlier invention of the cathode-ray tube.

With the development of the camera tube and receiving tube, electronic scanning was able to replace cumbersome and expensive mechanical scanning. The image orthicon, invented by Philo Farnsworth in 1928, improved upon Zworykin's iconoscope, but it was not until 1933 that electronically scanned television became a commercial reality.

Who named television?

Two men claimed to have coined the word television. One was Hugo Gernsback, then the publisher of *Radio News* (He later founded Gernsback Inc., the publisher of *Radio-Electronics* which was renamed *Electronics Now* in 1993).

In the August 1928 issue of *Radio News*, Gernsback wrote: "The word 'television' was first coined by myself in an article entitled 'Television and the Telephot' which appeared in the December 1909 issue of *Modern Electrics*." The other person who claimed to have coined the word in 1900 was a Frenchman named Perskyi. Ω

POWER CONTROL

continued from page 68

TR1 are all driven full on. Above that preset temperature threshold, all three components are cut off.

The gate-drive polarity in Fig. 12 is always positive, but the triac's main-terminal current is alternating. As a result, the triac is gated alternately. A triac's gate sensitivity differs, depending on its operating mode. Thus, when the temperature sensed by the thermistor is well below the preset temperature threshold, Q2 is driven full on and the triac is gated in two quadrants. This sends the full AC-line power to the heater.

However, when the room temperature is very close to its preset value, Q2 is driven only slightly on. Thus triac TR1 is gated on in only one mode and only half of the available AC-line power is available to the heater. Consequently, the circuit offers fine temperature control of the room.

Synchronous switching

Figure 13 is the schematic for an electric heater-control circuit with automatic zero-voltage synchronous AC-line switching based on the CA3059 (IC1). It provides simple on/off heater switching.

This circuit is similar to that of the light-activated power switch of Fig. 9 except that an NTC thermistor is the feedback sensor. The Fig. 13 circuit is capable of maintaining room temperature within one or two degrees Fahrenheit of the value set on potentiometer R1.

Figure 14 is the schematic for a proportional heater control circuit that is capable of regulating room temperatures to within one degree Fahrenheit of a preset value. A thermistor-controlled voltage is applied to pin 13 of IC2 (CA3059). Simultaneously, a repetitive 300 millisecond ramp waveform from pins 2 and 6 of IC1 (a 7555 or CMOS 555) is applied to pin 9 of IC2. The 7555 is configured as an astable multivibrator, and the waveform is centered on the half-supply voltage.

The triac is turned fully on synchronously if the room temperature is more than a few degrees below its preset level. However, it is cut off fully if the room temperature is more than several degrees above that preset level. When the temperature is within a few degrees of the preset value, however, the ramp waveform synchronously turns the triac on and off (in the integral cycle mode) once every 300 milliseconds with a duty cycle that is proportional to the temperature differential.

For example, if the duty cycle ratio is 1:1, the heater generates only half of its maximum power. However, if the ratio is 1:3, it generates only one quarter of its maximum power. This response causes heater output power to self-adjust to meet the room's preset heating demand.

When room temperature reaches the precise preset value, the heater does not switch fully off. Rather, it generates just enough output power to compensate for the room heat loss. This system gives precise room temperature control. Ω

HARDWARE HACKER

Basic stamp manuals, Fibonacci's sunflowers, a new Bezier spline book, Adobe's elegant Acrobat, and E-field AC voltage sensing.

DON LANCASTER

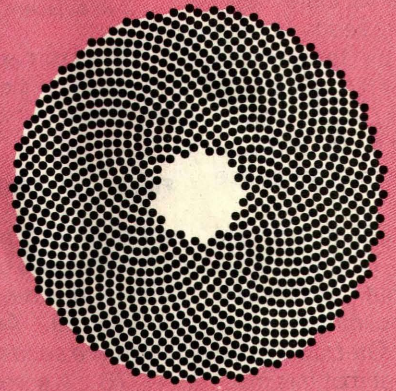
I have reviewed some new books that you might find informative. Lindsay Publications has republished dozens of books, mostly in the form of reprints of fascinating or "lost" technology from the past. For example, one is an authoritative 1935 book, *Neon Signs* by Miller and Fink. Others include a nine-volume *Cyclopedia of Formulas*, first published by *Scientific American* at the turn of the century. It contains "secret" processes for doing nearly everything from making your own dyes and chewing gum to electroplating, preparing artist's paints and doing photography.

One new book I found to be very useful includes some really hairy mathematics. I reviewed *Bezier* curves and cubic splines some time ago. Splines are the answer to the need for making use of sparse data to generate graceful two-dimensional curves or three dimensional surfaces.

Knot Insertion and Deletion Algorithms for B-Spline Curves is a difficult to read but definitive new book on splines. It explains the tricky process of breaking a single curve up into an indefinite number of subcurves, finding points along a single curve, or combining a pair of curves into one longer curve. The book includes many references to earlier papers on splines. The authors of the book are Goldman and Lyche, and the publisher is SIAM, the *Society for Industrial and Applied Mathematics.*

Fibonacci's golden sunflowers

Have you ever marveled at the way a sunflower's seeds are so compactly arranged along such mathematically precise spirals? Several botanists who have been impressed by this natural marvel are now questioning just how much of a plant's growth is determined by genetics, and how much is determined by mathematical algorithms and physical laws.



```
/golden 137.50776 def                        % super dooper magic number.
/rate 18 360 div def                         % base spiral expansion rate
/divergence 0.5 def                          % exponent - 1.0 is linear, 0.5 is best
/sweep 160000 def                            % total number of degrees in spiral
/inside 60 golden mul def                    % size of hole in middle
/dotrad 0.2 def                              % size of seeds

/dot1 {newpath dotrad 0 360 arc fill} def    % dot utility routine
/fixpack {dup 0 ge {divergence exp} {neg     % packing utility routine
   divergence exp neg} ifelse} def

/drawsunflower {inside golden sweep {        % start for loop
   dup dup rate mul fixpack                  % copy vector
   exch cos mul exch dup                     % find & save x position
   rate mul fixpack exch sin mul             % find y position
   dot1 } for } def                          % draw dot; end loop & proc

drawsunflower                                % draw the sunflower
showpage quit                                % and print it
```

FIG. 1—FIBONACCI'S GOLDEN SUNFLOWER is easily modeled with this simple PostScript routine. Many variations are possible.

The Algorithmic Beauty of Plants by Prusinkiewicz & Lindenmayer from the *Springer-Verlag Press* is an excellent (but heavy) book on this subject. However, a popular summary of the authors' ideas was published in the January 1995 *Scientific American* on pages 97 to 99.

It seems that there is a very complicated mathematical basis for the seed arrangements, but that math can be explored easily with the PostScript computer language. Figure 1 shows the fundamental algorithm that determines the seed arrangements. Actually, those spirals are visual *artifacts* that have nothing to do with the underlying generation algorithm. What you see are the *results*, and not the cause.

Start a very tight spiral, one that is not obvious. Then, for every 137.50776 degrees of rotation, plant a seed. That's all there is to it. Well, maybe not quite all. Do this and the seeds get farther and farther apart as the radius distance from the center increases. It seems that the outside seeds are gathered together with a value that I will call the *divergence*.

A divergence of 1.0 does nothing—it allows the seeds to spread out. A divergence of 0.5 gives the uniform result shown in Fig. 1. Another way of thinking about the 0.5 divergence is that it moves each seed toward the center by the *square root* of its radial distance.

All of the outside seeds in sunflowers tend to be larger and spaced farther apart than those closest to the center. A plant diverges by 0.6 or so but for for some far out artistic effects, try a divergence of 0.3.

The value of 137.50776 is critical and must be exact. This is a magic irrational number that has all kinds of artsy-craftsy applications. It is even related to the Grecian golden rectangle. It turns out that this magic number is also the limit for paired numbers in a *Fibonacci Series*. Figure 2 offers a few clues about what Fibonacci was doing.

A Fibonacci series is created by making each new term out of the *sum* of its two previous ones. Examples of this are 1, 2, 3, 5, 8, 13, 21, 34, 55, 89... And there is a related *alternate series* of 3, 4, 7, 11, 18, 29, 47, 76... A surprising number of natural physical processes occur in a Fibonacci pattern. Ironically, the Fibonacci series did *not* work in the subject area for which he initially developed them.

A mathematical **SERIES** is just a sequence of numbers. If you are given the early numbers and a set of rules, you can generate the rest of them.

Two obvious series examples are the **LINEAR SERIES** of 1, 2, 3, 4, 5, 6, 7 ... and the **SQUARE SERIES** of 1, 4, 9, 16, 25, 36, 49, 64....

A sequence called the **FIBONACCI SERIES** results when each new number is made from the sum of the previous two...

1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144...

Fibonacci sequences occur quite often in nature and in physical systems. The spiraling clockwise and counterclockwise sunflower **PARASTICHIES** are often two adjacent numbers in the Fibonacci Series. Such as 34 and 55.

The **LIMIT** of the ratios of sequential Fibonacci numbers is 0.618034. This is related to the Greek's **GOLDEN RECTANGLE** and is also precisely 137.50776 degrees around a full circle.

FIG. 2—THE FIBONACCI SERIES.

As the ratios of the paired Fibonacci numbers are taken higher and higher, they converge on a value of 0.618034. A distance that far around a 360° circle turns out to be 137.50776°. The inverse of that number is the Greek's record golden rectangle!

Those spiral artifacts are known as *parastichies*. They usually end up as two adjacent numbers in a Fibonacci series; in the case of Fig. 1,they are spirals of 34 and 55. To make the clockwise 34 spirals more obvious, reprint the figure larger with higher divergence. The inside of the spiral does not show up clearly, so I blanked it out. In nature, many real sunflowers do the same thing!

To run this code, just enter it into your word processor and send it to any PostScript printer with any communication program or by clicking the "send PostScript file'" on a printer driver. Alternatively, use *GhostScript* for on-screen viewing (more details on this are in STARTUP.PDF). Then change the parameters to get different patterns. I have summarized that algorithm in Fig. 3 for those who want to translate it into a less versatile or more primitive language.

I've posted ready-to-run code as SUNFLOUR.PS on *GEnie* PSRT. For some other astonishing examples of algorithm-driven growth, upload FRACTFERN.PS as well. Yeah, I also have some versions of Ghostscript available.

Simplicity strikes again

I have been snooping around inside Radio Shack's new 22- to 103-volt AC Voltage Sensor. This pen sized device lights up whenever it is placed within an inch or two of a live 120-volt AC source. You can hold it near a line cord to make sure power is available, or trace wires through the walls of your home. It allows you to quickly check fuses or circuit breakers, run "hot chassis" safety tests, troubleshoot series-wired Christmas tree light strings, or simply make sure power is off before doing any repair work on circuits.

Figure 4 is a simplified schematic of the voltage sensor. It is basically an E-field radio receiver for 60-Hz line radiation. Amazingly, the key component is a ten-cent hex inverter! The first inverter is biased into its active region so it behaves like a linear amplifier. To the metal tab antenna, this looks like a ×10 amplifier with an 8-megohm input impedance. Four more cascaded inverters together act as a high-gain clipping amplifier.

In the presence of an AC electric field, a 60-Hz squarewave appears

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across the LED, turning it on brightly. A resistor to ground on the output of the first inverter introduces the slight bias offset to ensure that the second inverter remains off in the absence of a 60-Hz signal. The sensitivity threshold can be adjusted by changing that resistor.

The capacitor performs two tasks: It bypasses any 60-Hz negative feedback to give the maximum AC gain from the first stage and it tests the battery by taking only a fraction of a second to charge when power is turned on. More elegant simplicity at work.

The circuit board has options for a buzzer and several other operating modes. The two "mystery resistors" are jumpers with low ohm values. I want to suggest two tips if you want to build your own sensor: The sensing antenna *must* be bare and exposed for maximum sensitivity. Also, be sure to use the "UB"(unbuffered) version of the CD4069 CMOS hex inverter. A 4069B has too much gain and will oscillate in the circuit.

(1) Start a long and tight spiral path.

(2) Every 137.50776 degrees, plant a seed.

(3) Optionally shift seeds towards center.

FIG. 3—THE SUNFLOWER ALGORITHM.

The drive transistor can probably be left out if you use a higher supply voltage and a high-brightness LED. Obviously, the circuit will not work if the wire that you are tracing is shielded, BX cable, in metal conduit, or there is metal between the sensor and the wire. And, of course, only "hot" wires can be traced through house walls. I have more details on CMOS linear amplifiers in my *CMOS Cookbook*.

Adobe's Acrobat

Which is preferable—a printed document or an electronic one? For permanent data storage nothing compares with a document printed with ink or toner on paper. It excells in legibility, pride of ownership, and its read-anywhere convenience. If these factors are important to you, there is just no way that any electronic document can approach it. If it does, it will not happen in the next five years.

By contrast, an electronic document is instantly available. It is never misplaced or out on loan. and can be corrected or updated easily long after it is first printed out. All copies are perfect originals. There is never any generation loss. Electronic documents do not wear out or deteriorate over time. They don't get mustard or coffee stains. They can be stored in far less space than printed pages and they are easily customized. And they can be shipped out much faster at much less cost.

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For typical users, unusual fonts are substituted with *multiple master* fonts. One serif, one sans. These are good enough for most users most of the time. The multiple master font has variable width, weight, and optical size. Yes, the page layout and exact text justification is fully preserved.

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By a special arrangement, I have uploaded DOS, Windows, and Mac Acrobat readers to PSRT, where it's free for the downloading. You'll get application notes, demonstrations, reference manuals, and many examples. Most of my latest column reprints are now in Acrobat form for instant on-screen viewing even without PostScript. I will update the earlier ones as time and money permit. Kate (my assistant sysop) and I have been uploading two or three original or unique files each day, so you're bound to find something new each time you visit.

Getting documents

What do you do if you must have your own hard copy of some technical article or standard? Where do you go for fast help? First and foremost, go on-line and snoop around. Thousands of sources are now scrambling to offer millions of Acrobat-format reprints to you. Many are free for the downloading through the Internet, the commercial online services, and even by way of local BBS systems.

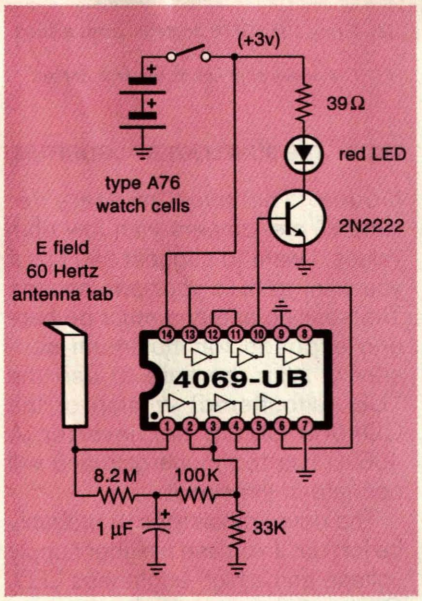

FIG. 4—A SIMPLIFIED SCHEMATIC of Radio Shack's 22 to 103 volt AC voltage sensor.

I have posted a few key document retrieval supply sources for this month's resource sidebar. The all time classic standby, of course, was interlibrary loan. Sadly, many libraries have dropped this service recently or have made it a tedious, expensive process. With far fewer participants, the odds of obtaining what you want are far lower. Today, an interlibrary loan is bound to be a frustrating waste of time.

Another traditional source is UMI, short for *University Microfilms*. It sells copies of any magazine or technical article from nearly any source. But to use UMI you must precisely specify the publication, volume, author, and page numbers. Cost varies with speed of service.

UMI recently added a sorely needed new service by opening *The Information Store*. It is a convenient place to find all the *really* hard-to-get material—documents such as conference proceedings, obscure reprints, and standards. Most of these are now stocked in depth by *Global Engineering Documents*. Their documents are pricey, but they do have what you want the instant you need it. It is usually cheaper and slower to go directly to the standards group.

By far, the best way to determine if a publication or document exists is through the *Dialog Information Service* by way of your local library, *GEnie*, or one of those other commercial on-line services. Dialog is great for searches and abstracts, but the other services might be better if you want hard copy.

The U.S. Government Printing Office can be a useful source for leaflets and brochures. They are now much easier easier to deal with from their 24 "retail" outlets. I have shown only one in the sidebar that goes by the catchy name of *U.S. Government Bookstore*. Contact them for a list of all of their other offerings.

Individual reprints of most of my columns are instantly available on *GEnie* PSRT. They are also available as book-on-demand bound hard copy from *Synergetics*. We can also find *any* document for you on a custom basis.

BASIC Stamp manuals

I looked at the $29 *BASIC Stamp* discussed two columns back. This is *the* hacker microcomputer. I have had lots of helpline requests for more information on this subject, so I made a special arrangement with Lance Wally from *Parallax*. I have uploaded the complete Basic stamp user manual to *GEnie* PSRT. You can obtain it free by downloading.

I have split the material into three pieces, a BASTAMP1.PDF introduction, the instruction set as a

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BASTAMP2.PDF, and dozens of detailed applications examples as BASTAMP3.PDF. Files are in Acrobat format, so you can easily view it on screen or print your own hard copy.

New tech lit

Plessey is offering a new *Consumer IC Handbook* that contains information on a full line of remote-control and satellite ICs. Plessey has also just released the GP1010 single-chip GPS (global positioning satellite) receiver front end, a companion application breadboard, and a GP1020 back-end six-channel correlator.

National Semiconductor is offering free samples of its new LM45 precision centigrade IC temperature sensor to qualified persons who request them.

Hewlett-Packard is offering free samples of IrDA infrared communication parts to prospective volume purchasers. A lot of useful information on remote infrared sensing appears in a free *Handbook of Non-Contact Temperature Sensing* from Exergen.

Two unusual trade publications that explore new desktop concepts are *Inside Finishing* on foil stamping and Kroy Color materials and *P-O-P & Sign Design* on new plastics and unusual prototyping materials. Both are valuable resources. P-O-P stands for *point of purchase*. Take advantage of the free copy of the *Embossing Arts* catalog that mentions a lot of desktop opportunities for hackers.

When you are about to go off your gourd, there's a support group called the *American Gourd Society* that can help you. It has a free catalog that's loaded with useful books and bulletins.

If you really want to immerse yourself in desktop publishing, check out my *Book-on-demand Resource Kit*. It contains all the information you'll need to get started to be your own publisher.

It's time for our usual reminder to check the *Names & Numbers* or that *Reprint Resources* sidebars for references on most of the subjects I've mentioned. And the PSRT access and a no-charge voice helpline is available per the *Need Help?* box. As before, I have arranged a special ten-hour free trial of GEnie for Hardware Hacker readers. A credit card is required for signup. Ω

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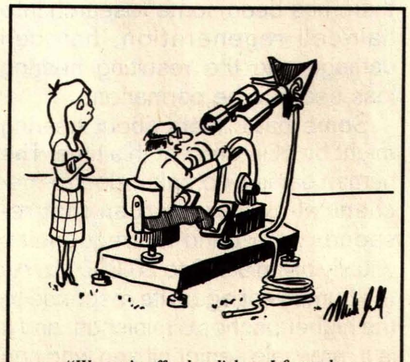

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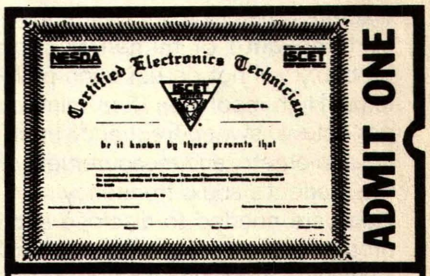
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AUDIO UPDATE

Taming the deafening decibels: Practicing "safe sound"

LARRY KLEIN

In last month's column, I began a discussion of the potential long-term, cumulative damage to student's hearing that could result from the high sound levels present at school dances. The subject arose out of my concern, as a parent, for my son's hearing. This month, the Q-and-A format is continued, with a look at how hearing damage occurs and what other concerned parents can do to protect their children's hearing.

Q. Will the audiological screening tests given in schools pick up signs of incipient damage?

Not necessarily. Some of the early warning symptoms are diminished ability to differentiate between adjacent tones and sharp dips in hearing response at narrow frequency bands. Conventional quick screening with just five or six discrete tones to cover the frequency bandwidth of human hearing probably will not detect such problems. High resolution (four minutes per octave) sweep-frequency tracking audiometry and measurement of the student's audio-frequency resolution are needed to disclose such problems. According to the Harvard Medical School Health Letter, reduced pitch discrimination is especially likely if the youngsters have experienced temporary audibility-threshold shift or several minutes of ringing in their ears after high-decibel exposure.

In a paper presented before the Audio Engineering Society, one researcher cited several audiological studies of students. In one case it was found that 3.8% of sixth graders failed a high-frequency hearing test, while 11% of 9th graders and 10.6% of high-school seniors failed it. A survey of incoming college freshmen yielded a 33% failure rate. The next year, 60.7% of the new incoming class failed. Those figures clearly imply an accumulation of damage.

TABLE 1
MAXIMUM ALLOWABLE OSHA LEVELS

Exposure Time (hours)	**Maximum Level** (dB)
8	90
4	95
2	100
1	105
0.5	110

Q. How does excessively loud sound cause hearing loss?

The injury from exposure to high sound levels takes place in the coiled, snail-shell-shaped structure in the inner ear called the cochlea. The fluid-filled cochlea is the final destination of the acoustic vibrations (sound, that is) forwarded via the eardrum and the tiny bones in the inner ear. Minute hair cells within the cochlea convert the acoustic vibrations into microvolt electrical signals that travel through the auditory nerve to the brain, where it is perceived as sound. Hair cells that have been exposed to excessive sound levels become twisted, bent, and/or fused, and are no longer able to respond properly to the incoming sonic vibrations. The ear's performance is degraded even when only a relatively small number of hair cells are damaged. Although there has been some research into hair-cell regeneration, hair-cell damage and the resulting hearing loss seem to be permanent.

Some basic facts about hearing might be of interest at this time. The human ear is a complex electro-mechanical-hydraulic organ that responds to a band of frequencies usually given as 20 to 20,000 Hz. As the human ear ages, its response to the higher pitches diminishes, and it is a rare male senior citizen who can easily hear frequencies much over 5000 Hz or so. (The higher harmonics of musical instruments are in this range.) Women, for some reason, suffer about half the age-induced hearing loss of men.

When the ear's middle- and high-frequency response is diminished, many of the defining sounds in speech become hard to hear, and comprehension is impaired. Some speech sounds that are higher in pitch (and softer than the vowels), such as "s," "sh," and "f," might not be perceived at all, and others, such as "p" and "t," might be confused. That occurs in many older adults well before they are aware that their ears' volume sensitivity is also impaired. In other words, sounds have to be louder to be heard at the same subjective level than when the ear (and the rest of the body) was younger.

It has been suggested that both of those effects are not inevitable, but rather are the result of the cumulative effect of the high sound levels common in "civilized" societies. Individuals in isolated cultures, such as the Mabaan tribe in the Sudan or the Easter Islanders, who have never been exposed to the sonic stresses of civilization, have been tested as having youthful hearing acuity well into old age.

Q. Rock musicians are constantly exposed to very loud sound. Why isn't their hearing affected?

It is. A nonprofit organization called H.E.A.R. (Hearing Education and Awareness for Rockers) was founded in 1988 to educate rock musicians and their audiences about the causal relationship between high-decibel sound and hearing impairment. The brainchild of Kathy Peck, a well-established musician, and Flash Gordon, MD, the organization soon found widespread support within the music industry. Its present membership includes musicians, physicians, audiologists, engineers, disc jockeys, and journalists. Executive Director

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TABLE 2—DECIBEL LEVELS OF SOME COMMON SOUNDS

Sound Pressure (dB)	**Sound Source**
130	Jack Hammer (at 5 feet)
120	Discomfort/Pain Threshold Loud Rock or Disco Music
110	Riveter Heavy Truck (at 50 feet)
100	Very Loud Classical Music
90	Heavy Street Traffic (at 5 feet)
80	Loud Singing Heavy Traffic (at 40 feet)
70	Fairly Loud Speech (at 3 feet) Department Store/Noisy Office
60	Background Music Average Office Quiet Residential Street
50	Light Traffic Average Residence
40	Very Low Radio at Home Very Soft Music
30	Country House Quiet Auditorium
20	Faint Whisper (at 5 feet)
10	Leaves Rustling Anechoic Chamber
0	Threshold of Audibility

Note: Sound-pressure level varies with distance from source.

Kathy Peck is militant on the issue of excessive sound levels because she herself suffers from a 40% hearing loss brought on by exposure to high-volume sound during her punk-rock performance days.

In addition to its many educational and public-service activities (including distribution of 8000 pairs of earplugs at Megadeth and Lollapalooza concerts), H.E.A.R. provides testing, counseling, and medical referrals to musicians troubled with hearing loss and tinnitus. Pete Townsend, who is one of H.E.A.R.'s strong supporters, stated at a press conference announcing the Who's reunion tour that "The real reason I haven't performed live for a long time is that I have very severe hearing damage." Many other musicians have publicly acknowledged their hearing problems, among them Joey Ramone, Jerry Harrison of the Talking Heads, Ted Nugent, and Jason Newstead of Metallica.

The solution for some performers is specialized earplugs that reduce the overall sound level by 15 to 18 dB without affecting the audible frequency response. Many classical musicians playing in the midst of large orchestras have also turned to hearing protectors such as "musician's earplugs" available from several manufacturers.

Q. Do you have any recommendations for the maximum allowable sound levels at school dances?

Several points relevant to this question have been raised in the research literature. First, there is a great individual variation in susceptibility to sound-induced hearing loss. In other words, a sound level that will induce severe tinnitus or threshold shift in one person, will leave another unaffected.

Because the OSHA-recommended 90-dB/eight-hour maximum sound-pressure level is based on average responses, it is reasonable to expect that a substantial number of persons are more sensitive than average and would benefit from lower maximum SPLs. Given that fact, it seems to me that it is best to be conservative in establishing a permissible maximum level at the disco dances. Also relevant is the fact that the OSHA recommendations are questioned by the EPA, which advocates a lower maximum of 85-dB/eight-hours.

The ISO standard also recommends lower sound levels for given exposure times.

I've not stressed the matter of overloud Walkmen, live heavy-metal concerts, or killer car stereos, all of which contribute to the din, and potential hearing loss. Because the damage accumulates over time as the cochlea's hair cells are knocked out one by one, it seems a wise policy to avoid sonic excess whenever possible, or wear earplug protection whenever you absolutely must indulge. Let's try to practice safe sound!

Given all the above, I would recommend that middle- and high-school disco dances operate with a maximum SPL reading of 85 dB (A-weighting, slow response, measured eight feet in front of the speakers). Measurements should be taken throughout the evening because of the previously mentioned threshold shift that impels DJs to turn up the volume as the evening wears on. Any microphone sing-along by the DJ should be included in the measurements. For monitoring purposes, I recommend the Radio Shack SPL meter (stock No. 32-2050). It sells for $31.99, is easy to use, and is certainly accurate enough for disco sound-level monitoring.

I'm aware that the 85-dB level might be unsatisfactory for a few in the audience (and the DJ), but it is far more important that the students do not suffer temporary threshold shift or short-term tinnitus (as a contributor to long-term damage) as the price of their fun. At all times, try to keep the kids from clustering within five feet or so in front of the speakers, as sound intensifies considerably at close range—which is probably the reason why they are there in the first place.

We all know that kids typically need to be called three or four times before they respond. Let's all help ensure that their behavior continues to reflect normal teen perversity rather than noise-induced hearing damage.

Q. Where can I get more information on the cumulative effects of excessive sound on hearing?

I've compiled a bibliography that lists suggested reading. Ω

DRAWING BOARD

This new circuitry for the audio router will assign a switch selection to one of four outputs.

Every year a new crop of electronic wonders shows up on the local store shelves, where they are bought by a public that is hungry for new features. If new features and technology are not added to last year's products, fewer people will buy them. In truth, however, most of the so-called "new technology" each year isn't really new at all.

The same can be said of my project designs. Complex projects are really just combinations of simple projects. All the elements of the audio router I'm putting together are things that I've done before. Those building blocks are proven circuits that have worked well for me many times over the years, and using them will help ensure that this new project will work as I expect it to.

The router

With that out of the way, I can get back to the audio router. The circuitry I've laid out so far "saves" pressing an input switch on the keyboard in a latch. Now I need a circuit that will let me assign that switch selection to one of four outputs. Because I want to have four outputs, I need four latches. As with the inputs, I've chosen to use CD4508B CMOS dual 4-bit latches.

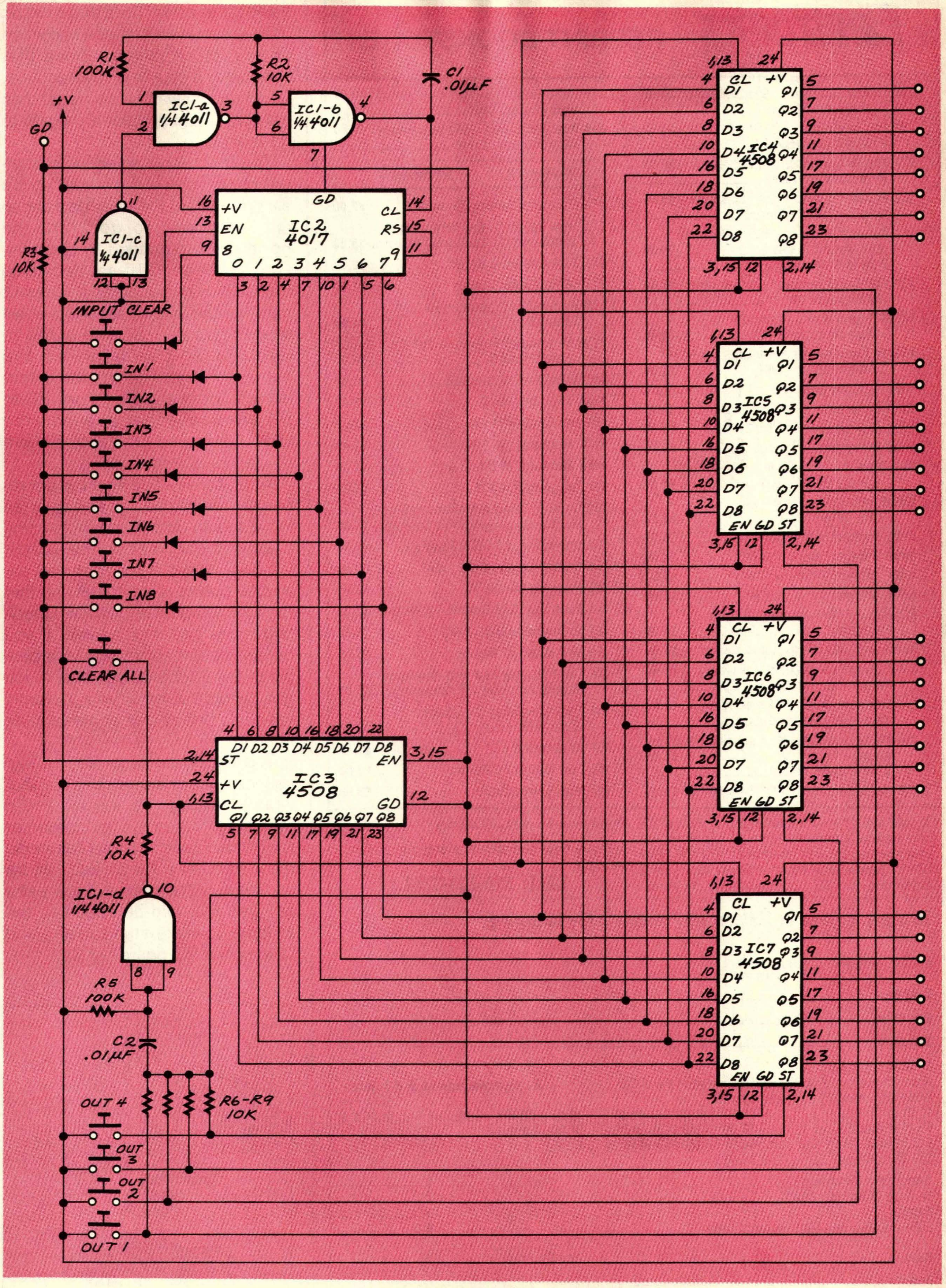
The layout for the output latches is shown on the right side of Fig. 1. The inputs to the latches form an eight-bit bus (one bit for each input). The latch outputs will be the control signals for the analog switches that will route the audio signals. As with the input latch, I don't need to control the enabling of the outputs because there's no possibility of bus contention at the output. Therefore I've grounded all of the 4508's enable (EN) inputs (pins 3 and 15 of each chip).

The clear (CL) inputs (pins 1 and 13) are also tied together so I have some way to clear all the output latches at once. In a similar manner, the store (ST) inputs (pins 2 and 14) of each chip are tied together and the resulting four lines are brought out to the four output selection switches previously mentioned.

Once you get this output section wired up, you can connect it to the input section you've already built. Five new switches have been added: four output select switches and a clear switch that clears both the output latches and the input latch as well.

Another function that was added to the circuit is a way to guarantee the state of all the latches when power is first applied. The 4508 is cleared when a high is put on the clear inputs, so a positive-going pulse must be generated at power up. Since there was one NAND gate left over in the 4011, I used it to build a half monostable multivibrator consisting of IC1-d, R5, and C2. When power is applied to the circuit, the brief positive-going pulse that appears at the output of IC1-d travels through R4 and clears all five of the 4508 latches in the circuit. Once that's done, the output of IC1-d stays logic low and prevents the clear inputs from floating.

You could use that same pulse to clear IC2, the heart of the keyboard section. When power is first applied to a 4017, there's no guarantee as to the state of its outputs. If you disable the keyboard clock, turn on power, and check the output pins of IC2, you'll see that the 4017 might have more than one output logic high—an illegal and somewhat confusing state. But that's corrected as soon as the chip gets a reset pulse. The reason I don't specifically reset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R2
10K
C1
.01µF
+V
GD
IC1-a
1/4 4011
IC1-b
1/4 4011
IC1-c
1/4 4011
IC1-d
1/4 4011
R3
10K
IC2
4017
+V
EN
8
GD
CL
RS
9
0 1 2 3 4 5 6 7
INPUT CLEAR
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
CLEAR ALL
IC3
4508
D1 D2 D3 D4 D5 D6 D7 D8
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8
ST
EN
CL
R4
10K
R5
100K
C2
.01µF
R6-R9
10K
OUT 4
OUT 3
OUT 2
OUT 1
IC4
4508
IC5
4508
IC6
4508
IC7
4508
EN GD ST

FIG. 2—THE COMPLETE CIRCUIT so far. Four output select switches and a clear switch that clears both the output latches and the input latch have been added.

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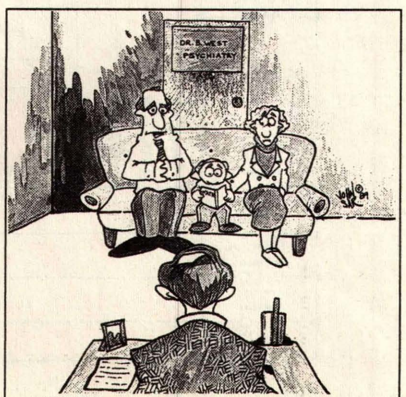
the 4017 at power up is that it will be done automatically after a maximum of nine clock pulses. Since that takes only a couple of milliseconds, I'd rather just wait for it to reset than have to add an additional OR gate to do the job.

The four output selection switches connect one of the output latch's store inputs to +V, which is a cheap and easy way to generate the positive pulse needed to store the latch contents. I did not debounce the switches because it doesn't matter if the latches receive a short train of pulses. The state of the inputs doesn't change, so the number of pulses sent to the output latch is irrelevant. Resistors R6 to R9 are connected between the store inputs and ground to prevent those inputs from floating.

After it's wired up, test the operation of the circuit by selecting an input and an output and then, using a logic probe, check the output latches. Make sure that the expected output is logic high and that the other outputs remain low. Check both clear switches as well. If you get consistent errors, you've probably miswired the output bus. If you get random errors, you probably have left one of the control inputs floating.

The circuit now generates the signals needed to control the ICs that will be doing the actual audio switching. When we get together next time, I'll add this final section to the circuit and the project will be complete. I'll talk about a few extra features that can be added to the switcher to make it more useful, and I'll supply a PC board layout. Ω



"Well doctor, we first became concerned when he refused to play Nintendo."

COMPUTER CONNECTIONS

WinHEC '95

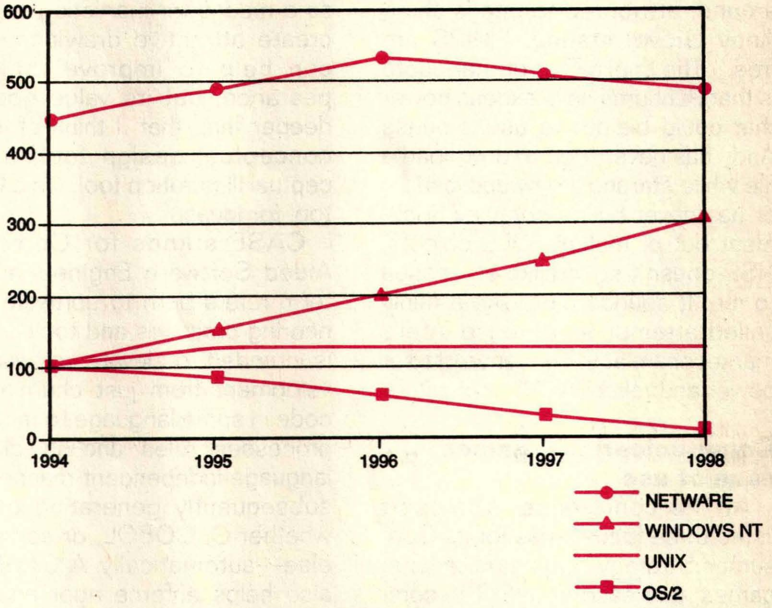
JEFF HOLTZMAN

Microsoft's annual Hardware Engineering Conference (WinHEC 95) was held in early spring this year on the West Coast. Many interesting standards, technologies, and products were discussed and demonstrated. Here are a few highlights:

Microsoft's General Manager of the Personal Systems Division, John Ludwig, displayed an interesting graph (Fig. 1, data courtesy of Forrester Research) showing projected shipments of network-server operating systems. Note that NetWare peaks in 1996, followed by a slow but steady decline. Unix continues to maintain a low-profile presence, OS/2 drops off sharply, and NT ramps up quickly. That might be wishful thinking on Microsoft's part, but the word on the street is that NT really is a product to contend with.

Figure 2 maps out Microsoft's strategic plan for operating system evolution. (The map was developed by Michael Slater, a microprocessor design wizard and newsletter publisher.) Note that the code name Memphis is where Windows desktop systems converges with Windows NT. Also note that DOS is just about dead. There may be a DOS 7; Microsoft still hasn't formally confirmed or denied. But it will almost surely be the last version.

Another interesting point, according to Slater: VESA local bus (VLB) is on its last legs. It was designed as a tactical solution to a need for higher graphics bandwidth. The PCI architecture, on the other hand, represents a fundamental redesign of the PC's I/O system. (I will discuss some of the differences here next month.) Slater also believes that the IDE architecture is likely to greatly overshadow SCSI, despite SCSI's universally acknowledged maturity, compatibility, flexibility, and performance. The primary reason is cost.



(WORLDWIDE SALES IN THOUSANDS) SOURCE: FORRESTER RESEARCH, INC.

FIG. 1—PROJECTED NETWORK OPERATING SYSTEM software trends over the next few years show IBM and Novell losing ground, and Microsoft gaining.

It seems to me that with IDE, the PC industry has once again allowed short-term cost considerations to override longer-term architectural considerations. Moreover, consumers will ultimately pay the price. (Just ask anybody who bought into the ESDI standard a few years ago.) Anyone who wants to add peripherals other than a hard disk or CD-ROM will end up adding a SCSI host adapter to his PC. For example, tape drives, scanners, printers, and CD-ROM writers all run with SCSI. With both SCSI and IDE peripherals to worry about, purchasing, configuring, and maintenance will all be more complex, hence more costly.

On the other hand, another new standard promises to increase flexibility, reliability, and performance of the I/O subsystem. The standard is called the Universal Serial Bus; it was developed primarily by Intel and Microsoft. USB offers daisy-chain architecture, with identical connectors on all devices, and a single port on the PC. No more plugging the scanner into the printer port! USB provides 12-megabit/second performance in a master-slave arrangement, and it can accommodate devices such as a keyboard, mouse, joystick, modem, ISDN link, speakers, microphone, and even mass storage devices. USB is intended as an inexpensive solution to I/O port proliferation and attendant configuration hassles; implementations should be available by the end of the year.

A more advanced technical solution, known variously as FireWire, Serial SCSI, SCSI 3, and IEEE P1394, is also being discussed. This new standard promises much higher performance, but at higher cost, and it will take longer for it to reach the market.

Intel has begun promoting its Native Signal Processing (NSP) architecture. The basic idea behind it is to reduce hardware cost by eliminating dedicated signal processors (such as those used for modems and sound and video processing), and off-load the tasks to the host CPU—most likely a high-end Pentium. There's a quote floating around, attributed to Intel's chief, Andy Grove, stating, "MIPS are free." The implication of that quote is that Pentiums have excess power that could be put to use. I guess Andy has never tried to download a file while starting a new application, or has never built a complex document out of multiple OLE objects. NSP doesn't sound like a panacea to me; it sounds more like a thinly veiled attempt to increase Intel's market share at the expense of user power and reliability. No thanks.

Communications, games, ease of use

At the conference, Microsoft listed three focus areas for its Consumer Strategy: Communications, games, and ease of use. The communications goals break down into two main components: 1) Making the PC the premiere communications appliance, and 2) Providing interactive, rich connections to everybody, everywhere. Is there anything to stop Microsoft from reaching either goal? Is there any reason why one would want to?

As for games, Microsoft wants to make the PC the premiere "edutainment" platform, primarily through enhanced multimedia capabilities, underlying system architecture, and development tools. As for ease of use, the company wants to "make the PC as easy to use as a toaster." Good luck.

Microsoft has drawn a line in the sand about the basic system configuration of the 1996 PC: Plug and play BIOS, 1024 × 768 × 8 video, advanced serial (but not USB) and parallel ports, PCI bus, and power management. For consumer computers, CD-ROM, audio, joystick, and modem are required. For corporate computers, networking, telephone-based communications, and writeable CD-ROM technologies are important. RAM, CPU, and mass storage capacities were not specified for either consumer or corporate computers.

A CASE tool for ideas

In the past I have written here about Visio, a drag-and-drop drawing tool that runs under Windows. Many people (including some who ought to know better) think of Visio as a means for inartistic people to create attractive drawings. Visio can help to improve their appearance, but its value goes far deeper than that. I think of it as a conceptual design tool, a conceptual illustration tool. It's a CASE tool for ideas.

CASE stands for Computer-Aided Software Engineering; the term refers both to software engineering practices and tools. CASE is intended to elevate software development from just churning out code in some language to modeling processes, rules, and objects in a language-independent manner, and subsequently generating code—whether C, COBOL, or something else—automatically. A CASE tool also helps enforce rigor and consistency in the models it creates.

Visio can't generate code, and it can't enforce rigor or consistency. But it can be used for analyzing and describing any complex problem that must be broken down into multiple levels of components with complex interrelations.

Visio's template-based approach is the visual equivalent of integrated circuits. Instead of plugging in 555 timer ICs or 7404 hex inverters, you use visual symbols (including all kinds of electronic symbols). Unlike hardware components, it is a simple process to create your own Visio components, as well as to modify the built-in components. Visio's object-oriented architecture even allows you to go in and change the way a component functions. Then the functions of all examples (in a particular drawing) adopt the new attributes.

From an electronics viewpoint, the program could sorely use a PC board trace-routing mechanism that would feed from a schematic diagram. On the other hand, with the current version and a little programming, one could derive a complete parts list from a schematic.

What I really want is a whiteboard-size, touch-screen version of Visio. Meanwhile, if your work involves any form of technical illustration or conceptual modeling, get a copy of Visio. I am sure you won't be disappointed.

Is there life after Lou?

Recently I had the *pleasure* of ordering some equipment from IBM. The experience was, shall we say, educational.

The problem was my client whose office had only IBM computers. He wanted to buy some engineering consulting time from my company. Because of the vagaries of corporate politics and economics, the client could not hire full-time employees, nor could he purchase equipment. But his company was allowed to hire all kinds of contractors, and the contractors were even allowed to fold the costs of required equipment purchases into the hourly rate. Fine. That's what keeps us in business.

IBM has a service agreement with my client's company, a manufacturing concern with an international presence. The agreement, in essence, states that no non-IBM equipment can be attached to the company's network. If it does attach them IBM will not accept responsibility for servicing *anything* connected to the network. OóooK—what's wrong with this picture?

That put my company, and me in particular, in the position of having to buy a real IBM brand personal computer. Fine; I buy systems, peripherals, and components all the time. It shouldn't be too difficult to select and purchase a state-of-the-art system—right?

Wrong. First I went through my client's purchasing contact, a distributor in New Jersey. I quickly found out that the distributor could not help me configure a system, did not know the difference between IBM's main PC lines (the 300 and 700 series), and couldn't even give me prices on various system configurations over the phone. Big help.

Next I tried several mail-order vendors, the kind that advertise in Computer Shopper. Those companies were able to assemble config-

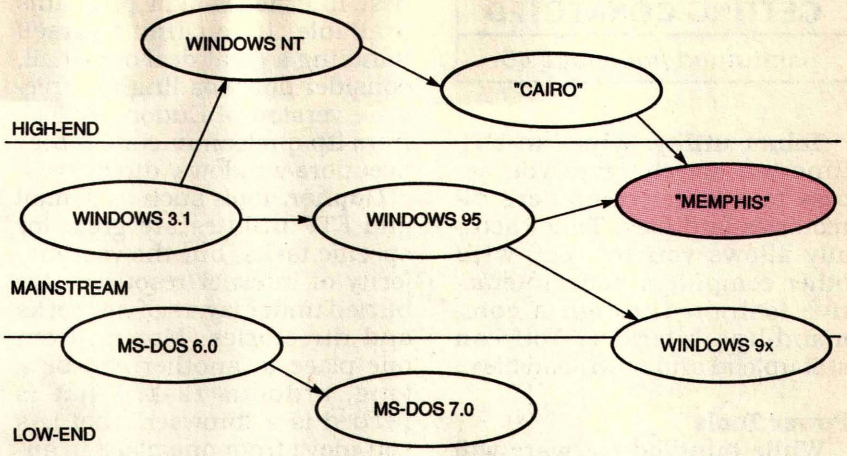


FIG. 2—ALL ROADS LEAD TO MEMPHIS, not Cairo, as formerly believed. Memphis will unify Microsoft's divergent OS products, but when?

urations and prices over the phone. However, their prices were no better than the prices of the "special" distributor in New Jersey—and delivery was measurable in months.

Last, I tried IBM Direct. The salesman I spoke with was more knowledgeable than the mail-order vendors on the subject of configuration. In addition, he provided me with an 800 number from which I was able to obtain detailed technical information. That really was nice, and much better than I could obtain from the mail-order vendors.

After some negotiation over price and system configuration, I purchased a computer with a 90-MHz Pentium processor, 16MBytes of RAM, and a 540 MByte hard disk. I wanted a 1 GByte hard disk, but IBM couldn't supply one. I wanted a CD-ROM, but IBM was out of stock. I wanted a 17-inch monitor, but IBM's cost $300 more than a comparable model from a local dealer. I ended up spending about $3200. If I had purchased an IBM monitor, it would have been about $4200. By contrast, several months earlier, I had purchased several P90 systems from Micron Technology, each with 32MBytes of RAM, 1 GByte hard disk, CD-ROM, 17-inch ADI monitor, DOS, Windows, and Microsoft Office—all for a total of about $4000 per system.

By comparison, I got about twice the memory and storage capacity, and a suite of application software, for the same amount of money. Hello?

The IBM sales person promised to ship the machine by air freight. It arrived several weeks later by UPS ground delivery. Inside the computer, a cage that holds disk drives had not been snapped into place properly, so the floppy disk drive came through the case at an angle. I picked up a quad-speed CD-ROM and a monitor from my local vendor, installed them, and the system worked fine.

The computer has an interesting feature called "Resume." It allows you to shut the machine off, even in Windows, and resume exactly where you left off next time you turn the computer on. Unfortunately, Resume was incompatible with our networking software (Lantastic 5.0), so I had to disable it.

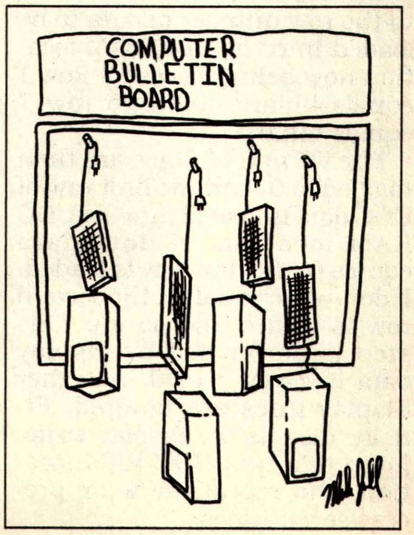
Mechanically, the IBM computer was well built, although not as well built as the PS/2s of old. The motherboard has six SIMM slots and built-in accelerated video, along with enhanced IDE ports and the usual serial, parallel, mouse, and keyboard ports. Copies of PC-DOS and Windows were installed on the hard disk, but there were no backup copies on floppy disk or CD-ROM. Beneath the Windows directory was a directory called Drivers; it contained the compressed format drivers for the Windows' Setup program. If you wanted to delete that directory to save space, you'd have no way to install new drivers.

All in all, 'twas an interesting experience. Obviously, the "New" IBM still has some learning to do.

E-mail

K. Woodmensch of St. Louis takes me to task for Microsoft bashing in the "Ubersoft" column in the March issue of *Electronics Now*. I am neither pro nor con Microsoft, IBM, or any other company. I am pro user. I want the best products at the best prices for the user. In some applications, Microsoft provides the best products; in others, it does not. In the areas where Microsoft does well, such as word processing, spreadsheet, and desktop database applications, it has not always done so. Its competitors (Lotus and Word Perfect) gave the market away. In the areas where Microsoft does not—yet—have the best products (network operating systems, compilers, project management, presentation, desktop publishing and graphics), there is still room for the competition. Can Novell, Borland, Symantec, Scitor, Harvard Graphics, and Corel stand up? I sure hope so. We need more than one giant vendor of computer software.

Late-breaking news: Beta 3 of Win95 was just released, but several major new bugs have surfaced. One relates to 32-bit multitasking, and the other relates to the fact that heavy use of system resources causes system crashes. Microsoft still intends to release the product in August, but that date looks shaky. Maybe we should call it Win9x—or WinEver, as suggested by one trade publication. Comments to jkh@acm.org. Ω



GETTING CONNECTED

continued from page 40

Telnet utility. While an FTP function merely gives you access to another computer's directories and files, Telnet actually allows you to work with other computers in an interactive fashion through a command-line interface. You can still upload and download files.

Power Tools

While bundled software will get you onto the Internet, it will only take you just so far. Fortunately, there are many more shareware and freeware programs that will make it easier for you to take advantage of Internet resources. The programs listed below are all available right off the Internet. Locations where they can be contained are listed for your convenience.

Eudora. This is one of the best Internet E-mail programs available. If you find yourself handling a great deal of E-mail, consider downloading the freeware version of Eudora by FTP from ftp.qualcomm.com in the /pceudora/windows/ directory.

Gopher. Tools such as E-mail and FTP utilities are great for specific tasks, but the vast majority of Internet resources are buried under layers of networks and directories; Moving from one place to another can be a long, arduous task. What is needed is a "browser" that lets you move from one place to another as efficiently as possible. The Gopher tool is perhaps the most effective browser for the Internet. You can find a freeware copy of Gopher by FTP from lister.cc.ic.ac.uk in the /pub/wingopher/ directory.

Trumpet. Another feature of the Internet is the availability of Usenet news groups. Basically, network news groups are electronic discussion areas where people can post questions and exchange information. To subscribe to and participate in news groups, you will need a news reader utility such as Trumpet. Trumpet is available as shareware ($40), and be downloaded by FTP from ftp.utas.edu.au in the /pc/trumpet/wintrump/ directory.

Mosaic One of the most exciting developments on the Internet is the World Wide Web (WWW) which offers a vast array of documents combining text, images, sound, and video. Mosaic is a tool designed to browse the WWW - it also provides limited FTP, news, and Gopher services. Mosaic is freeware available by FTP from ftp.ncsa.uluc.edu.

Getting connected to the Internet is only the first step to a world of information. Once you're connected, you'll find such a wealth of information that your only problem will be sifting through it. Ω

SMART DISPLAYS

continued from page 62

pletely. Listing 6 and Figs.8 and 9 explain how this is done. The first line of code sets integer udc—ram equal to 28H, (equal to binary 101000). This initial value is required to access the UDC RAM. Then hex 28H is sent to port B. That sets $\overline{\text{FL}}$ and A3 to 1, while also setting A4 to 0. Display lines A2 to A0 correspond to the row number of data to be loaded into the UDC RAM location now being accessed. Row 1 equals binary 000, and row 7 equals binary 110.

The $\overline{\text{WR}}$ and $\overline{\text{CE}}$ lines are then toggled to 0, and the first row of UDC data is loaded into the UDC RAM location. If dot—data equals 0, the first row is loaded. If dot—date equals 1, the second row is loaded and so on. This step is performed by display data lines D4 to D0. All other display lines are ignored. Finally, disable the display write, jump to a new UDC RAM location, and repeat the write process seven times.

To display the UDC symbol that was defined, recall in the discussion of the character RAM that it stores either ASCII character data or a user-defined character (UDC) address in each character RAM location. Those UDC RAM addresses correspond to all of the 16 UDC addresses shown in Fig. 2.

Refer to the end of Listing 6. To access the symbols created, access the character RAM by setting $\overline{\text{FL}}$ and A4 to A3 to 1, while setting A2 to A0 to the digit location where the UDC symbol is to be displayed. Toggle the lines to perform a write, and then insert the location of the ADC symbol in the ADC RAM. Set display data line D7 to 1, and lines D3 to D0 to the ADC RAM location where the symbol is stored.

Projects and source code

This project offers an opportunity for self-teaching the fundamentals of interfacing a personal computer with exterior circuits and devices, a subject not now covered in textbooks. You are encouraged to experiment with making the display scroll forward and backward, or even getting it to scroll vertically with the UDC functions. You can access the display self-test function, or you might want to build a computer driven moving message panel.

If you want to write and improve source code, you might want to purchase the author's source code diskette listed in the Parts List. It contains the complete listings of all code used in this article and also has a menu-driven executable program that goes beyond the examples given here (source code included). In addition, a second executable program allows special messages to be typed into the display (source code included).

The port address selector circuit gives you a way to send digital code to circuits or devices outside of your computer system. This circuit can be used to control or troubleshoot many different kinds of digital logic. For example, you could write data to your display and then read it back into your computer through the Port Address Selector. Ω

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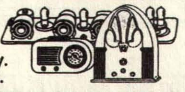

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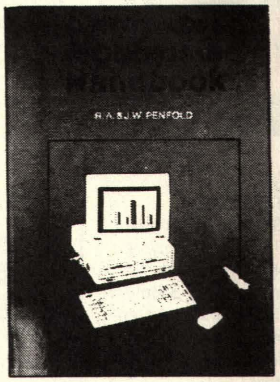

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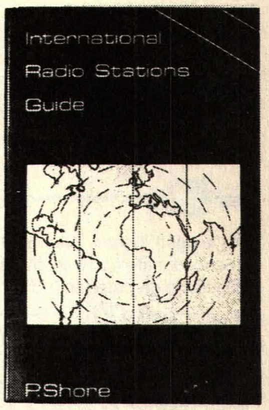

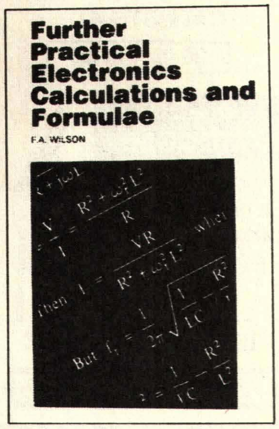

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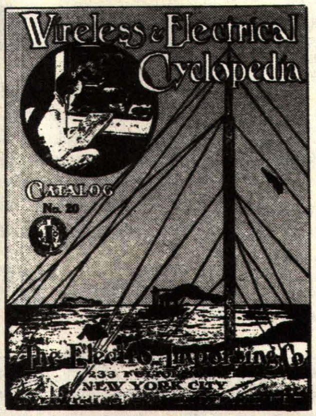

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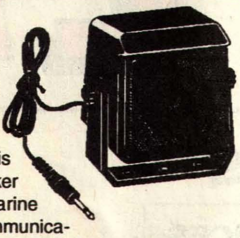
SPECIAL PURCHASE

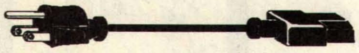


Improve and amplify the sound quality of most hand-held and mobile transceivers. This extension speaker for Ham, CB, marine or business communications improves clarity in noisy environments. Black case, grill and adjustable mounting bracket. 6 foot cord with 3.5mm mini-phone plug. 2.78" X 2.6" X 2.1" deep.

CAT# SH-3 **$6.00 each**

A.C. LINE CORDS

6 INCH IEC POWER CORD

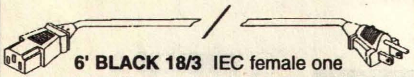


That's right! 6 inch...Standard 3 prong grounded male one end and 3 prong IEC receptacle on other end. CSA listed.

2 for $1.00 Large quantity available. **CAT # LCAC-36**

10 for $4.50 • 100 for $35.00

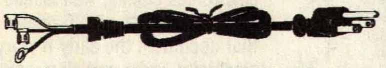
6 FOOT IEC (SPH-386) CORD



6' BLACK 18/3 IEC female one end, standard grounded three prong male on other end.

CAT# LCAC-60 **$3.00 each**

ROUND 4' BLACK 16/3 CORD

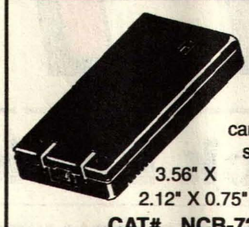


0.32" od, SJT insulation. Standard 3 prong grounded plug one end, molded strain relief on other end. Pigtail leads. CSA listed. Large quantity available

CAT # LCAC-35 **$1.75 each**

100 for $150.00

7.2 Volt, 1000 mAh NICKEL-CAD PACK

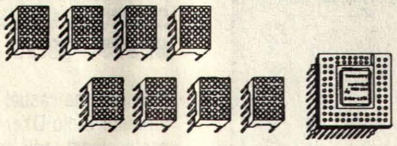


Brand new rechargeable nickel-cadmium batterypack fits Olympus and other camcorders. Originally sold for over $35.00.

3.56" X 2.12" X 0.75"

CAT# NCB-72 **$5.50 each**

MATRIX DISPLAYS WITH SMART DRIVER

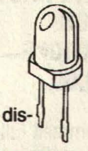


Hewlett Packard# HDSP-L203

Eight 5 X 7, 0.68" high LED dot matrix displays along with one PGA-type smart driver. The driver can decode 128 ASCII characters which are permanently stored in ROM. In addition, 16 programmable symbols may be stored in on-board RAM. The IC is designed for standard microprocessor interface techniques and is accessed through a bi-directional eight-bit data bus. Operates on 5 Vdc. Spec./hook-up sheets included.

CAT# AND-203L **$7.50 each**

JUMBO LEDs



Liton # LTL 327C - 8MM

Ideal for eye-catching indicators and displays. A recent quantity purchase of these BIG, 8mm diameter, red diffused LEDs enables us to provide some very special pricing. The leads on these devices are 0.325" long, with plenty of room for soldering.

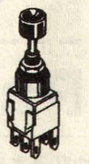
5 for $1.00 **CAT# LED-23**

100 for $ 15.00

1000 for $ 120.00

MOISTURE RESISTANT D.P.D.T SWITCH

REDUCED PRICE !



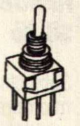
Augat/Alcoswitch # MPE206N Miniature DPDT, push/on push/off switch. Splashproof: O-ring on shoulder and inside movable shaft provides moisture seal. Rated 6 amps @ 125 Vac. RED 0.4" dia. cap. 0.25" diameter threaded bushing. 0.8" behind panel depth. Solder lug terminals. UL and CSA listed.

CAT # MPB-20

$1.75 each **25 for $37.50 ($1.50 each)**

MINIATURE TOGGLE

D.P.D.T. (ON-ON)



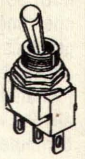
ALCOSWITCH # MTM206NPC

Short bat handle, 0.25" long. PC terminals.

CAT# MTS-82PC **$1.25 each**

25 for $25.00 • 100 for $90.00

S.P.D.T. (ON-OFF-ON) MOMENTARY ONE DIRECTION



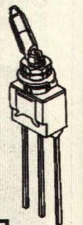
ALCOSWITCH # MTG106H

Standard toggle handle and 15/32" diameter bushing with miniature body. Rated 5 amps @ 125 vac. Center-off, momentary "on" in one direction.

CAT# STS-41

$1.50 each **25 for $ 31.25**

S.P.D.T (ON-ON) LOCKING TOGGLE



ALCOSWITCH #AL0LKWB

Locking toggle handle prevents accidental switching. Wirewrap pins.

CAT # MTS-43

$1.50 each **25 for $ 21.25**

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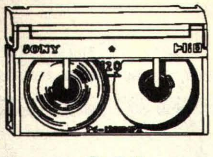
"HI-8" VIDEO CASSETTE (USED)

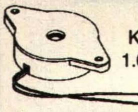


SONY Hi-8 T-120 Top quality, metal particle 120 minute video cassettes. Used for a short time, then bulk-erased, each cassette has its own plastic storage box. Satisfaction Guaranteed.

CAT# VCU-8 **$3.00 each**

10 for $28.00 • 100 for $250.00

PLASTIC ENCASED PIEZO ELEMENT



1.72" DIA. X 0.53"

Kyocera # KBT-44SB-1A 1.0 Khz. 75 db min. @ 10 V p-p Louder than non-encased piezo elements. Requires an external signal to produce a sound.

CAT# PE-26 **75¢ each**

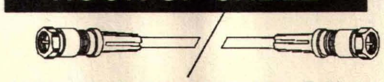
10 for $6.50 • 100 for $50.00

5 WAY MULTI-POINT TEST LEADS

High quality, flexible, cloth covered red and black test leads with telecom industry standard 5 way multipoint test clips on one end and spade lugs on the other end. 5 ways to connect clips: 1) U-shaped nose for qc terminals; 2) Notched jaw for gripping screws, wires or terminals; 3) Serrated teeth for threaded or wire wrap terminals; 4) Cluster of small needles for piercing small gauge wires; 5) Large piercing needle for piercing larger wires. 4 feet long. At one end of the cord is a 1500 ohm resistor that can be switched in and out of circuit.

CAT# TL-200 **$3.50 per set**

6 FOOT VIDEO HOOK-UP CABLE



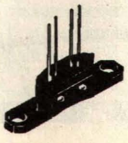
High quality 6' video patch cables. Belden # 9104 "Duobond" dual shielded RG-59 cable with heavy-duty F connectors hex-crimped onto each end. Large quantity available.

CAT# VHU-6S

$1.00 each

10 for $7.50
100 for $60.00

REFLECTIVE OPTO SENSOR



SHARP # 2L01 0.75" mounting centers.

75¢

CAT# OSR-9

OPTO SENSOR

SHARP # GP1I52 0.12" gap.

CAT# OSU-23

2 FOR $1.00

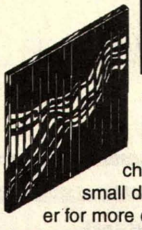
GREAT DEAL!

SURFACE MOUNT SPEAKERS

These surface mount speakers were designed for use with car stereo, but they will work as well, or better as intercom or communications speakers in your home or workshop. 4", 4 ohm, speakers mounted in an unbreakable black plastic, slant-faced enclosure. They are rated 5 watts. Enclosure measures 4.82" X 4.5" X 2.45"h.

CAT# SK-411 **$3.75 per pair**

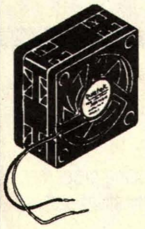
9 VOLT 60 MA SOLAR PANEL



These 6" X 6" glass enclosed photovoltaic panels produce 9 Vdc at 60 ma. Ideal for charging batteries and powering small devices. Put two or more together for more current and voltage. Includes hook-up instructions.

CAT# SPL-960 **$5.25 each**

MINI 12 Vdc COOLING FAN



Delta "Quietek" # SB0412M 12 Vdc, 0.12 amp mini cooling fan. 0.57" (40mm) square X 0.79" thick. 12" long pigtail leads. Ideal for cooling CPUs and small switching supplies. Moves a lot of air for its size.

CAT# CF-22 **$7.50 each**

12 VOLT FLUORESCENT LIGHT STICK

LIGHT STICK

12 volt, 8 watt fluorescent tube with cigarette lighter plug and alligator clips for running on 12 volt DC power. Comes with handy floor stand and hook for hands free operation. Lamp is protected by clear plastic housing. 15' cord. Ideal for emergency road repairs, working in a garage or outdoor lighting.

CAT # FL-1

$8.50 each

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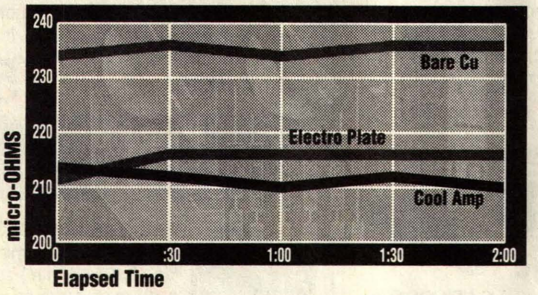
In recent independent tests Cool-Amp is proven __better__ than electroplating.

(For 50 years we've said Cool-Amp is "equal to" electroplating in performance. __It is better.__)

Cool-Amp

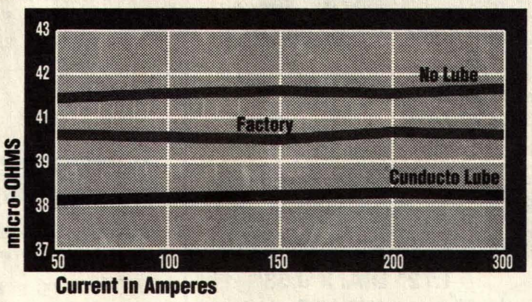


From the report:

"...compare the conducting properties of Cool-Amp silver plating compound with factory silver elctro-plated bus and bare copper bus.

"The test results indicated that the contact resistance of the Cool-Amp plated bus connection was slightly lower than that of the electro-plated bus connection and much lower than that of the bare copper bus connection. The final temperature at temperature equilibrium of the bus connection employing Cool-Amp was slightly lower than that of the electro-plated bus connection and the bare copper bus connection..."

Conducto-Lube



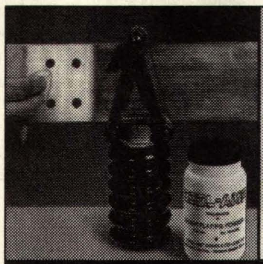
From the report:

"...compare the conducting properties of Conducto-Lube lubricant with factory lubrication and non-lubricated connections on an air switch. Identical test setups and procedures were used for each test so that comparative data could be collected and the relative performance of each type of connection could be quantified.

"The test results indicated that the contact resistance of the switch employing Conducto-Lube was generally lower than that of the factory lubricated switch and the switch that used no lubricant."

Cool-Amp How it works:

- Applies *on the job.* Application is simple. Yet Cool-Amp adheres permanently. As tests show, it is better than electroplating.
- Minimizes overheating and power loss by silver plating high amperage connections.
- Saves time, reduces maintenance. Cool-Amp is so simple to apply on the job. It assures maximum conductivity for copper, brass, or bronze contacts and prevents losses due to oxidation.



A one-pound bottle of Cool-Amp silver plating powder plates approximately 6,000 square inches.

Conductivity is demonstrated by inserting test prongs into a container of Conducto-Lube and establishing a circuit. Photo shows low voltage (115 VAC) continuity through container.

Conducto-Lube How it works:

- This is *the* conductive lubricant; highly conductive because it contains pure silver.
- Originally developed to lubricate switches, to the point tension can be adjusted to factory specs allowing full rated capacity of the switch to be maintained at all times.
- Uses have continued to expland–from switches and breakers–to any application where a conductive lubricant is needed.

***Various tests were performed on both products in the Electro-Test, Inc. facilities in Portland, Oregon during January-March, 1994. Evaluation of plating thickness of Cool-Amp was performed by Surface Science Laboratories of Mountain View, California.**

COOL-AMP Conducto-Lube

Cool-Amp Conducto-Lube Company
15834 Upper Boones Ferry Road
Lake Oswego, Oregon 97035
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503/624-6426, Fax 503/624-6436

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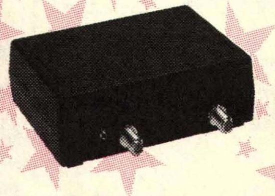
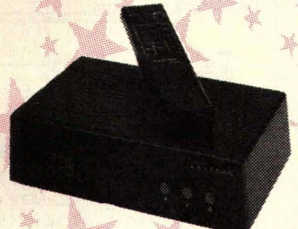
Mini TVT-3G	$42	PIO+	$69





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Channel 3/4 Switchable
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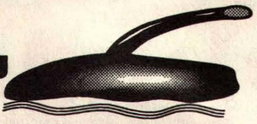
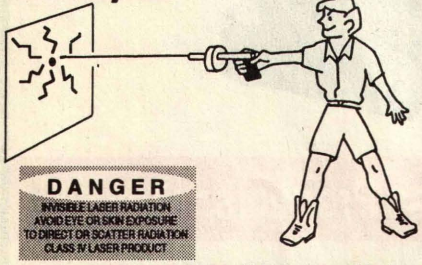


Remember War of the World? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

ANT1K Easy to Assemble Kit / Plans $19.50

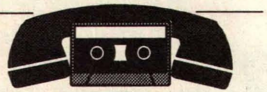
Laser Ray Gun


DANGER
INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTER RADIATION
CLASS IV LASER PRODUCT

Advanced project produces a burst of light energy capable of burning holes in most materials. Hand-held device uses rechargeable batteries. 500 joules of flash energy excite either a neodymium glass, yag or other suitable 3" laser rod. This is a dangerous CLASS IV project (individual parts/assemblies available). **LAGUN1 Plans $20.00**

LAGUN1K Kit / Plans ....Price on Request

Extended Play Telephone Recording System



READY TO USE! Automatically controls and records on our X-4 extended play recorder, taping both sides of a telephone conversation. Intended for order entry verification. Check your local laws as some states may require an alerting beeper.

TAP20X Ready to Use System..................................... $129.50

Shocker Force Field/ Vehicle Electrifier

Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great payback for those wise guys who have wronged you!

SHK1KM Easy to Assemble Electronic Kit............. $24.50

Electric Charge Gun

All New Technology!

Stuns/immobilizes attackers up to 15 feet away!
•Legal in most state (not in NY, NJ, MA, WI) • More knock-down power than most handguns • No permanent injury • ID coded • Free 80KV stun gun with every purchase.

ECG1 Data Packet, Creditable toward purcase $10.00

ECG10 Charge Gun, Ready to Use, w/Free 80KV Gun $249.50

Homing / Tracking Transmitter

Beeper device, 3 mile range.

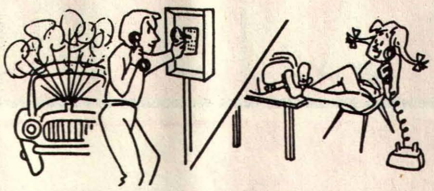
HOD1 Plans ....$10.00 HOD1K Kit / Plans $49.50

Listen Through Walls, Floors

Highly sensitive stethoscope mike.

STETH1 Plans.........$8.00 STETH1K Kit/Plans $44.50

Infinity Transmitter ++



Telephone Line Grabber/ Room Monitor / Controller

All New - The Ultimate in Home/Office Security & Safety!

Simple to use! Call your home or office, push a secret tone on your telephone keypad to access: • On premises sounds and voices • Ongoing phone conversation w/break-in capability • Up to 10 external electrical functions, lights, TV, alarms, coffee pots, heater, etc. CAUTION! Check legality with your state's attorney general's office before use for monitoring of voices.

TELECOM2 Kit, includes PC Board $149.50

TELECOM2 Ready to Use..$199.50

Visible Beam Laser

Easy to build, RED Beam, visible for miles. Use for light shows, window bounce holography, cloud illumination and much more! **LAS1KM Kit w/1mw Laser Tube, Class II. $69.50**

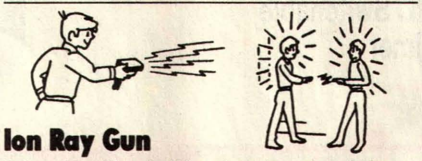
LAS3KM Kit w/2.5mw Laser Tube, Class IIIA $99.50

Life is Precious - Protect It!

Hard hitting 200.000 volts of crackling, sizzling plasma. Stuns and immobilizes most attackers

STUN40 Ready to Use.. $69.50

STUN10 Smaller Unit $39.50



Ion Ray Gun

Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. **IOG3 Plans $8.00**

IOG3K Kit/Plans.. $69.50

Invisible Pain Field Generator

Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.

IPG7 Plans ....$8.00 IPG7K Kit/Plans ...$49.50

IPG70 Assembled $74.50

1000 Ft++ Potato Cannon

NOT A TOY. Uses electronic or piezo ignition. CAUTION REQUIRED!

POT1 Plans.......
(Dangerous Product).............$10.00

FireBall Gun

Shoots flaming ball - two shot capacity Great for special effects and remote fire starting. CAUTION REQUIRED!

FIREBALL Plans (Dangerous Product).....$10.00

TV & FM Joker / Jammer

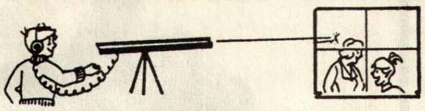
Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required.

EJK1KM Easy to Assemble Electronic Kit..................... $24.50

ATTENTION: High Voltage Fans!

4,000 volts in the palm of your hand! Experiment with anit-gravity, hovercraft, ion guns, force fields, plasma guns, shock devices, wireless energy and electrical pyrotechnics. Input: 9-14VDC.

MINIMAX4 Ready to Use.. .$ 19.50



"Laser Bounce" Listener System

NEW - Latest Technology! Allows you to hear sounds from a premises without gaining access. Aim at room window and listen to sounds from within via reflected laser light. Not for illegal use. Requires video tripods.

LWB3K 5mw Laser and Receiver Kit.......................... $149.50

LWB30 Ready to Use, includes Laser Gun Sight......... $199.50

5mw Visible Red Pocket Laser

Utilizes our touch power control!

VRL5KM Kit / Plans.................................$ 74.50

Electronic Hypnotism

Puts subjects under control using highly effective electronic stimuli. Intended for parties and entertainment but must be used with caution. Includes valuable text book reference and plans.

EH2 Plans and Text Book... $19.50

Automotive NEON!

Easy-to-Install
4-Tube Kit
for Cars, Trucks, Vans!

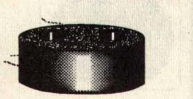
Available in Pink, Purple, Blue or Green - please specify color when ordering.

RG4K (Specify Color) ....$ 129.50

♪ **Flash-To-Music Option for above kit FMU1...........................$ 29.50**

License Frame Kit
(Specify Color)
LIC1K ....$ 24.50

3 Mi FM Wireless Microphone



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To determine whether a video head is in good condition by detecting the wear state of the video head and indicating it on the meter. This will serve as a tentative guidance for confirming the wear state of the video head.(Dim:4.7"HX5.5"WX1.2"D)

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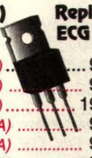

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7805	*(Pos VR, 5V, 1A)*	960
7806	*(Pos VR, 6V, 1A)*	962
7809	*(Pos VR, 9V, 1A)*	1910
7812	*(Pos VR, 12V, 1A)*	966
7818	*(Pos VR, 18V, 1A)*	958
7824	*(Pos VR, 24V, 1A)*	972
7905	*(Neg VR, 5V, 1A)*	961
7906	*(Neg VR, 6V, 1A)*	963
7912	*(Neg VR, 12V, 1A)*	967
7915	*(Neg VR, 15V, 1A)*	969
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F Male for RG 59/U Cable

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- 1/4" ring included

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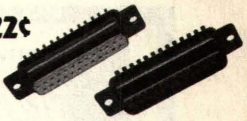
Minimum 100 pieces

D Sub Connector

22¢



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6 feet long

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4	17-1460	Universal Type

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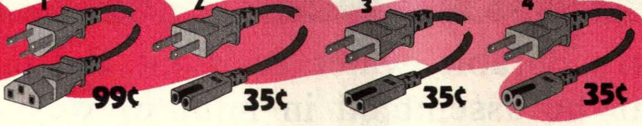

99¢ 35¢ 35¢ 35¢

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C .... 55-670 ...... 4Way

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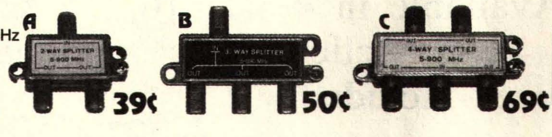

39¢ 50¢ 69¢

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- 75-300 Ω

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- LED power indicator
- Polarity Reversing Switch
- Switchable 110/220VAC 50/60 Hz
- 6' Molded Cable with Multi-connector

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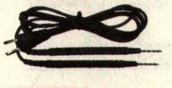

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4.7uF/50V	5¢
10uF/50V	6¢
22uF/50V	7¢
33uF/50V	8¢
47uF/50V	9¢

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22uF/25V	5¢
33uF/25V	6¢
47uF/25V	7¢
100uF/25V	8¢
220uF/25V	9¢
330uF/25V	10¢
470uF/25V	11¢

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7812	47¢
7815	47¢
7818	47¢
7824	47¢
7905	50¢
7908	50¢
7912	50¢
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LM317T	80¢
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5mm (T1 3/4) Diffused LEDs

Red	7¢
Green	8¢
Yellow	9¢

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CERAMIC DISC

(All caps rated 50V)

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22pF	5¢
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47pF	5¢
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Deal 'R4': 40 pcs total, (5pcs of each).....$2.50

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2.2uF/35V	20¢
10uF/35V	35¢

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on-on	SPDT	56¢
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.022uF	5¢
.047uF	6¢
.1uF	6¢

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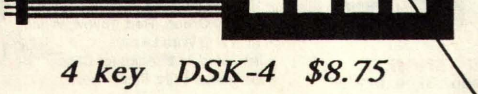

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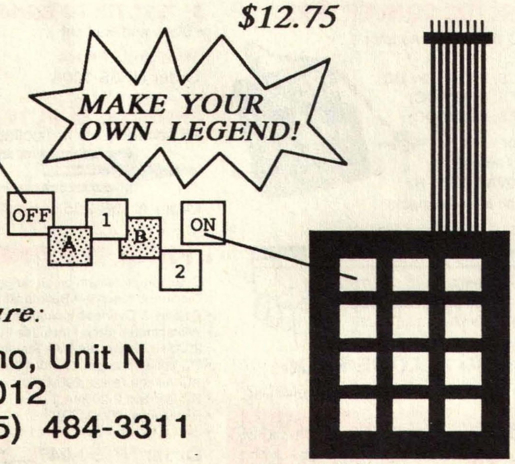

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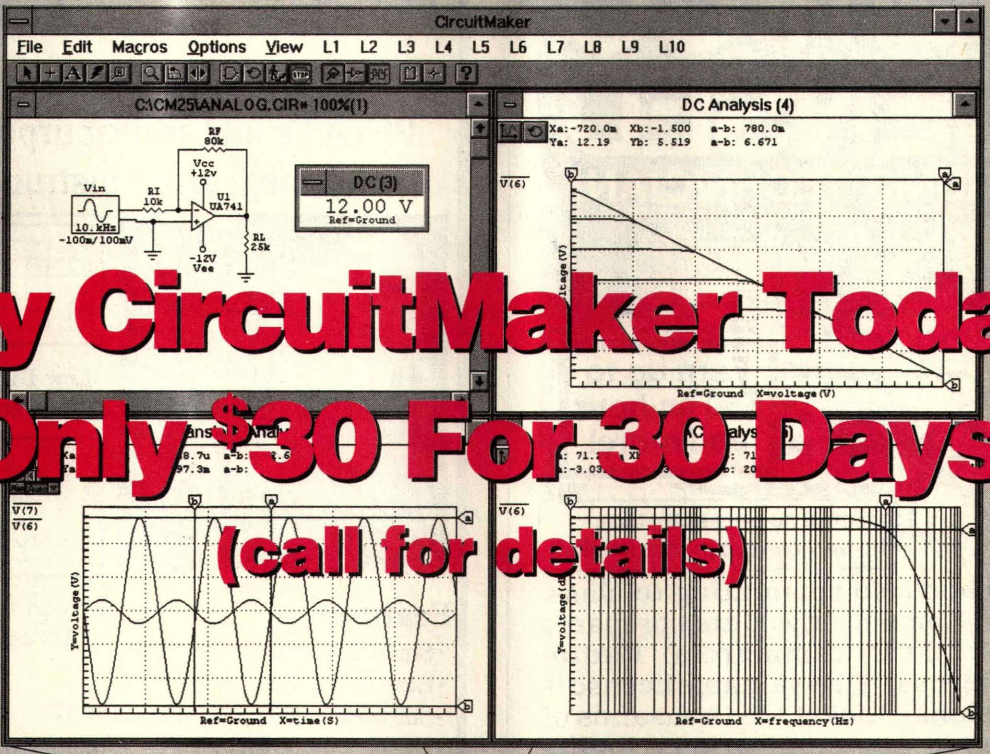
Electronic Workbench has no interactive logic probe or Trace capability and no Hex or ASCII keys. Their "word generator" is limited to 16 words. EWB does not have tri-state devices and digital devices do not have programmable propagation delays.



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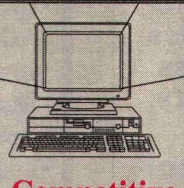

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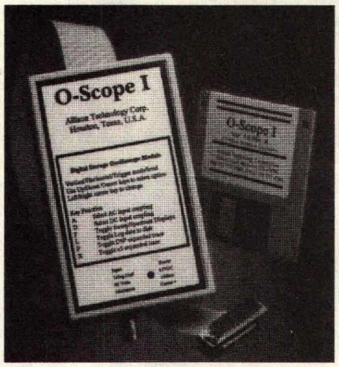

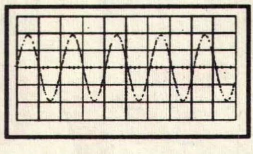

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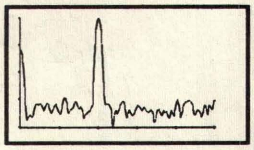

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- Optional Dual Trace
- Logging to Disk
- Print Screens
- Optional Probe Sets
- Optional Ext. Trigger
- Power 12VDC, 40 ma.
- Made in U.S.A.

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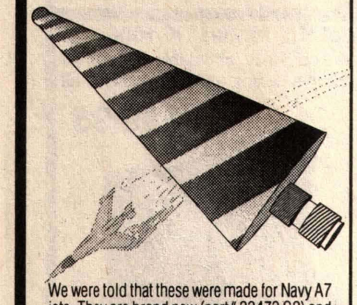
Allison Technology Corporation

8343 Carvel, Houston, TX 77036

CIRCLE 320 ON FREE INFORMATION CARD

A7 JET COUNTERMEASURES ANTENNA

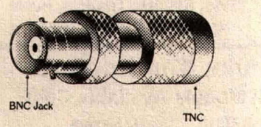


We were told that these were made for Navy A7 jets. They are brand new (part# 23473 G2) and are in sealed military packaging. The antenna looks like a 5 1/4" ice cream cone with 2 foil spirals. At the base of the cone is a TNC female connector. We used an adaptor to connect this antenna to a scanner and the increase in sensitivity of the scanner to frequencies above 800MHz was amazing! Antenna is encapsulated for rugged use, very high quality and if nothing else, makes a great conversation piece. Can you imagine what the Navy must have paid for these things? Own a piece of high tech military history before we run out!

G6662 **$8.00**

TNC - BNC JACK ADAPTOR

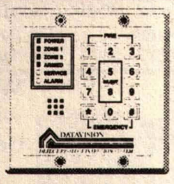
(FOR ABOVE)



Allows you to simply connect the above antenna to your scanner using a BNC - BNC cable.

G6663 **$4.00**

CONTROL PANEL KEYBOARD



Keyboard with 6 LEDS and ribbon cable. Make fake alarms as this is the same unit found on the front door control panels for many professional home alarms. Size: 4 9/16"sq.

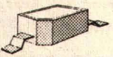
G2904

~~WAS $3.00~~

SALE! ONLY $2.75!

10/$23.00

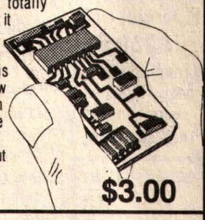
ULTRABRIGHT SMD RED LED



Very intense clear lens tiny SMD ultrabright red LED made by Panosonic. Type LN1261CAL. Prime-on tape and reel.

G6447 **4/$1.00**

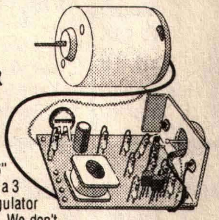
BASIC SMD LEARN TO SOLDER KIT



Contains 1 small SMD single sided circuit board which is etched (ready for component mounting), and over 50 various SMD components: ICs, resistors, capacitors. There isn't room to mount all the parts, but we give you extra ones in case you ruin them. The circuit is totally nonfunctional, but it is a tremendous way to introduce yourself to this exciting new technology which industry all over the world is adopting. Size of board about 1 1/2" x 3/4".

G3113 **$3.00**

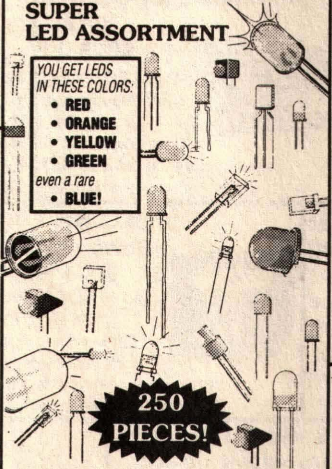
HEAVY DUTY 12VDC MOTOR WITH REGULATOR



Precision 1 7/16" Dia. motor has a 3 transistor regulator board attached. We don't have the hookup diagram on these, but they look like sophisticated electronic regulator boards. Size of board: 1 1/2" x 2 1/8". Size of motor: 1 7/16"Dia. x 1 7/8" L. The shaft is a "D" type and 1/2" long. Brand new-no other info available except that these were made by Sonar Radio Corp., part# 27-030-008.

G6540 **$1.50**

SUPER LED ASSORTMENT



YOU GET LEDS IN THESE COLORS:

- RED
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- YELLOW
- GREEN

even a rare

- BLUE!

250 PIECES!

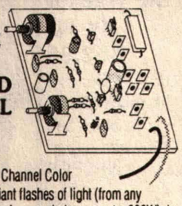
Assortment of all types, colors, sizes and shapes of prime high quality LEDS. This large assortment even contains a clear LED that lights up blue! Our largest and most spectacular assortment contains 250 pieces.

G6554 **$10.00**

NOTE: All sale prices advertised are valid only through the month of the cover date.

IF YOU CAN'T FIND WHAT YOU ARE LOOKING FOR, CALL FOR A **FREE** COPY OF OUR LATEST CATALOG. THIS CATALOG CONTAINS OUR ENTIRE PRODUCT LINE OF OVER **3,500** ITEMS AND IT IS STILL GROWING!

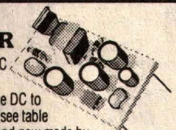
SUPER SENSITIVE SOUND ACTIVATED 2 CHANNEL COLOR ORGAN



This ultra sensitive 2 Channel Color Organ produces brilliant flashes of light (from any incandescent lamps of your choice - up to 200W) in response to music or other sounds. This is probably the best and brightest color organ we have ever seen. It is fully assembled (except for line cord and outlets) and features 2 response controls, on/off switch, sensitive FET microphone (no hookup to stereo needed) and 3 transistor, 2 SCR circuitry. Operates from standard 120VAC and requires only that you solder your line cord and 2 outlets (for your lamps) to the board. We strongly recommend that you install the color organ in an insulated case for safety reasons as it operates from the AC line. Connect up a couple of your brightest, colorful lamps and watch the fireworks with each beat of the music! Great for DJ's as there is no connection to the sound source. Size of board: 3 3/4" x 4 1/4". Color organ board only - you supply lamps, line cord, knobs, case and outlets. Hurry, these will sell very fast!

G3319 ~~WAS $5.95~~ SALE! ONLY $4.95!

DC TO DC CONVERTER



Super efficient tiny DC to DC converter converts lower voltage DC to a higher voltage DC (see table below). These are brand new made by TDK and are only 1 3/8"L x 7/8"W x 3/8"T. Very efficient and latest technology using SMD and standard technology. Power a 9V transistor radio from 1 AA battery, charge several AA batteries from one solar cell, power a 9V project using 1 or 2 AA cells, etc. Has only 4 leads (±in and ±out). With hookup diagram.

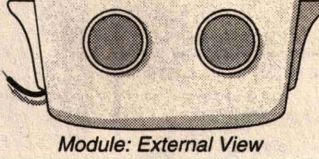
Power Table

Voltage Input DC	Voltage Output DC	Current Output
0.5VDC (solar)	3V	1mA
1.5VDC	9V	15mA
3VDC	9V	40mA

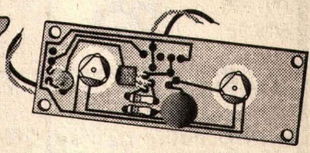
G6344 **$3.98**

HUMAN VOICE AND VARIOUS SOUND MODULES

Small electronic modules have 2 pushbuttons that produce human voices and various sounds. You need only to provide a speaker and 4.5VDC (3 AA batteries connected in series works fine). Size of modules about 4" x 2 1/4". Only 4 wires to connect (2 for power and 2 for the speaker). We have 4 different modules:



Module: External View

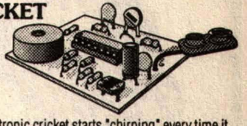


Module: Internal View

	Voice Button	Sound Button	STOCK#
1)	"Emergency 911."	Ambulance Siren Sound	G6664
2)	"Unload."	Idling Dump Truck Sound	G6665
3)	"Fire! Let's Go!"/Siren	Idling Fire Truck Sound	G6666
4)	"Load em up!"	Race Car Revving Up Sound	G6667

YOUR CHOICE $1.25 each **100 for $100.00**

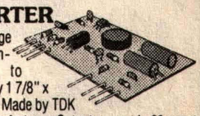
ELECTRONIC CRICKET KIT



This electronic cricket starts "chirping" every time it gets dark. Of course, if you turn on the lighs to look for the "cricket" it becomes silent again. Loads of fun. Uses 9V battery (not included). Skill level 1.

C6707 **$5.30**

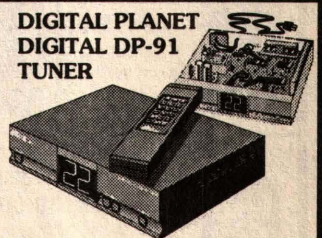
TDK VOLTAGE CONVERTER



Brand new voltage converter converts 3VDC to 9VDC. Size only 1 7/8" x 1 3/16" x 1/4". Made by TDK for a major manufacturer. Output current is 60 ma at 9VDC. Use 2 penlight batteries to operate transistor radios, calculators, etc, or any electronic device that can operate on 9VDC at up to 60ma. With hookup diagram (only 3 leads are used).

G6546 **$2.00**

DIGITAL PLANET DIGITAL DP-91 TUNER



These are complete infrared controlled FM digital tuners. The were made to decode digital CD music that was transmitted from satellites to your local cable company. We were told that the satellites these were set up for are no longer transmitting- we don't know. We do know that the main unit consists of a sophisticated tuner circuit and readout circuit that displays any channel number 00 to 26 when you press the buttons on the remote control. After a while the display shows EE indicating that the cable TV signal is not present. Inside the 9 3/4" x 6 5/8" x 2 3/8" main unit are various IC's, readouts, a custom microprocessor IC, tuner module, power transformers, resistors, caps, diodes, etc. Use this for experimenting with digital tuners, IR remote control, etc. We have absolutely no info except the instructions for operation that came with the units. You get the complete DP-91 digital stereo tuner and 1 infrared remote control which uses 2 AA batteries (not included). These look new but probably were taken out of service when the satellite programming ended. Looks like a great hobbyist item but to take apart the main unit you will need to use a torx type screwdriver. *Hurry, limited quantity!*

G6506 **$15.95**

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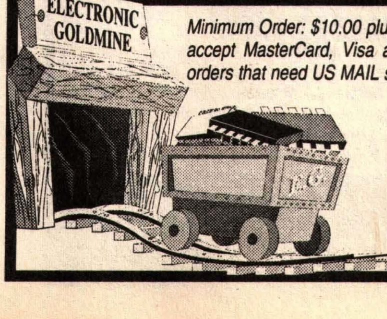
*Or **Fax** Your Orders To **(602) 451-9495***



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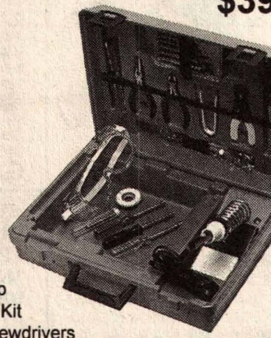

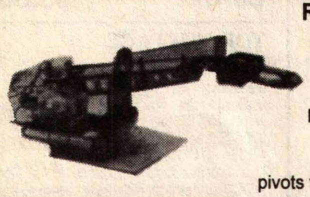

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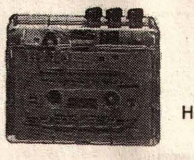
(Wired Control)
Movement grabs & releases, lifts & lowers, pivots from side to side



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12 Functions
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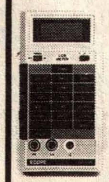
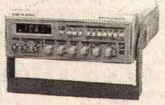


Digital LCR Meter
LCR-680
$79.95
3-1/2 Digit LCD Display
Inductance 1uH to 20MΩ

Function Generator
GF-8026
$239



Int/Ext Operation
Sine, Square, Triangle, Pulse Ramp, .2 to 2MHz, Freq Ctr

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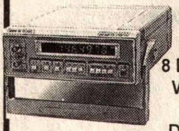

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3 fully regulated supplies; 1.5-15V @ 1A, -1.5 to -15V @ 1A or 3-30V @ 1A & 5V @ 3A **Kit XP-620K $49.95**

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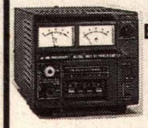
Four supplies in one unit; 2-20V @ 2.5A, 5V @ 3A, -5V @ .5A and 12V @ 1A. All regulated and short protected



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12A @ 13.8V
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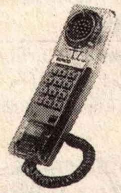

Available Assembled
PT-223
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Function Generator Blox
#9600
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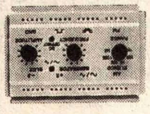

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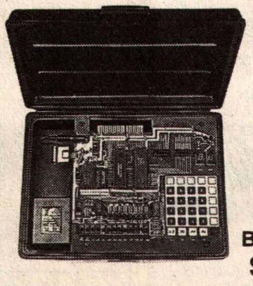

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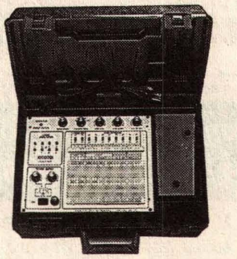

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Kit
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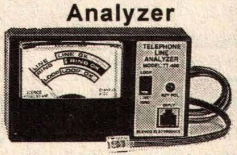

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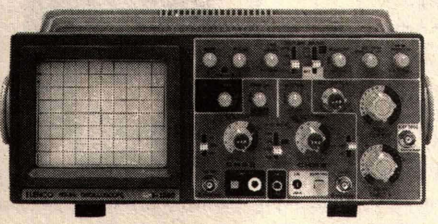


60MHz

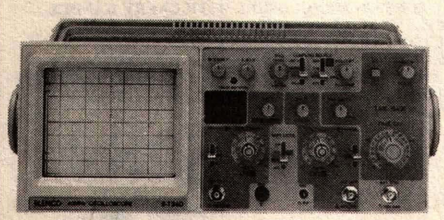
S-1360 $775

Delayed Sweep

S-1365 $849

Cursor Readout

- Voltage, Time
- Frequency differences displayed on CRT



40MHz

S-1340 $495

2- Channel

S-1345 $575

Delayed Sweep

- Beam Find
- Component Tester

25MHz

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2- Channel

S-1330 $449

Delayed Sweep

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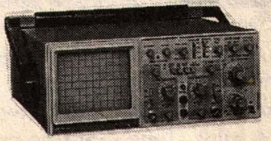

Delayed Sweep

Model 2125 $539.95

40MHz DUAL -TRACE

Model 1541B

$749.95

- 1mV/div sensitivity
- Video sync separators
- Z axis input
- Single sweep
- V mode-displays 2 signals unrelated in frequency

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- Sweep to 5ns/div
- Dual time base
- Signal delay line
- Component tester
- V mode-displays 2 signals unrelated in frequency

100MHz THREE-TRACE

Model 2190

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- 1mV/div sensitivity
- Sweeps to 2ns/div
- Dual time base
- Signal delay line
- 19kV accelaerating voltage
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20MHz ANALOG with DIGITAL STORAGE

Model 2522A

$869.95

- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2k memory per channel
- 20MHz equivalent time sampling

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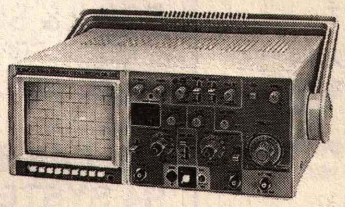
V-1065A - 100MHz, DT, w/cursor	$1,695.00
V-1085 - 100MHz, QT, w/cursor	$2,125.00
VC-6045A - 100MHz, Digital Stor	CALL
VC-6025A - 50MHz, Digital Stor	CALL

Elenco DS-203 20MHz, 10MS/s Digital Storage Oscilloscope



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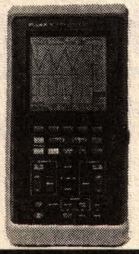
A handheld instrument that combines a 50MHz, 25MS/s dual channel digital storage oscilloscope with feature-packed 3000 count digital multimeter.



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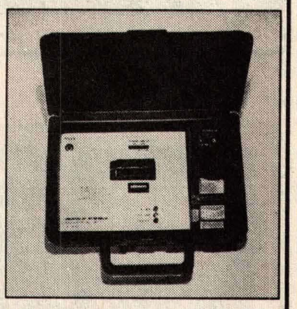

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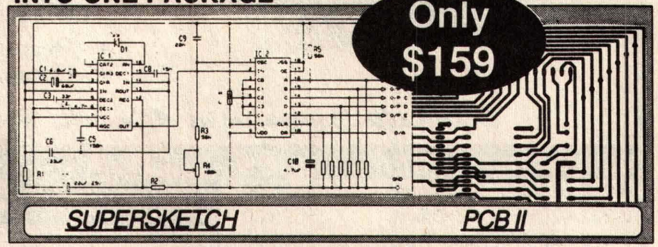

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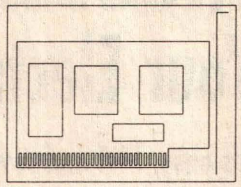

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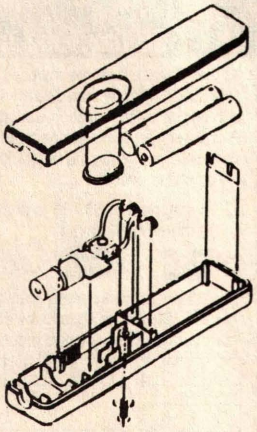
$39⁰⁰

Features:

- 4 mW, 670 nm Red Output.
- Adjustable Focus Lens.
- Operates for Hours on 2 AAA Batteries.
- Compact Size: 4.5" x .95" x .60"
- Easy to Assemble.



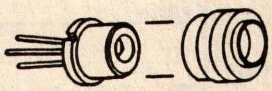
Laser Diodes

Factory NEW Units with Specification Sheets.

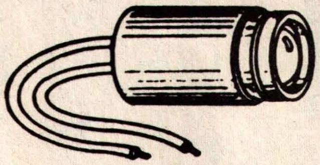
Toshiba #TOLD-9200 3 mW, 670 nm	**$20⁰⁰**
Hitachi #HL-6411G 3 mW, 635 nm	**$99⁰⁰**
Sharp #LTO-15MD 40 mW, 830 nm	**$75⁰⁰**

Collimating Lens

Press Fit Over Diode **$15⁰⁰**



Laser Diode Module

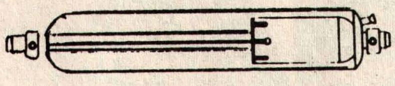


$39⁰⁰

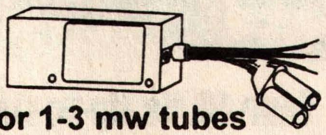
Features:

- **670nm visible red output**
- **Operates on 3 VDC**
- **Compact size**
- **New with factory warranty**

He-Ne Lasers



Brand new, 3 mW tubes **$20.00**



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QTY	1	100	1000
RAD. LYTIC 25VDC			
1µF	.05	.040	.035
2.2µF	.05	.040	.035
3.3µF	.05	.040	.035
4.7µF	.05	.040	.035
6.8µF	.05	.040	.035
10µF	.05	.045	.04
22µF	.05	.045	.04
33µF	.06	.055	.05
47µF	.06	.055	.05
100µF	.08	.07	.05
220µF	.08	.07	.055
330µF	.09	.08	.06
470µF	.10	.09	.08
1000µF	.22	.20	.17
2200µF	.42	.40	.38
3300µF	.53	.50	.47
4700µF	.91	.87	.83
RAD. MONO 50V			
.001µF	.05	.045	.035
.0022µF	.05	.045	.035
.0047µF	.05	.045	.035
.01µF	.05	.045	.035
.022µF	.05	.045	.035
.047µF	.05	.045	.035
.1µF	.05	.045	.035
.22µF	.25	.22	.18
.47µF	.42	.35	.28
CERAMIC 50V			
5pF	.05	.038	.025
10pF	.05	.038	.025
18pF	.05	.038	.025
22pF	.05	.035	.025
27pF	.05	.038	.025
33pF	.05	.038	.025
47pF	.05	.038	.025
68pF	.05	.038	.025
82pF	.05	.038	.025
100pF	.05	.038	.025
120pF	.05	.038	.025
150pF	.05	.038	.025
180pF	.05	.038	.025
220pF	.05	.038	.025
270pF	.05	.038	.025
330pF	.05	.038	.025
470pF	.05	.038	.025
1000pF	.05	.038	.025
2200pF	.05	.038	.025
3300pF	.05	.038	.025
4700pF	.05	.038	.025
.01µF	.05	.038	.025
.022µF	.05	.04	.03
.047µF	.07	.055	.035
.1µF	.07	.058	.04

CRYSTALS

QTY	1	100	1000
HC18 case			
1.8432	.89	.67	.45
2.0000	.74	.55	.39
3.5795	.74	.55	.39
3.6864	.74	.55	.39
4.0000	.74	.55	.39
4.9152	.74	.55	.39
5.0688	.74	.55	.39
7.3728	.74	.55	.39
10.000	.74	.55	.39
11.000	.74	.55	.39
11.059	.74	.55	.39
12.000	.74	.55	.39
14.3181	.74	.55	.39

frequencies are in MHZ

DIODES

QTY	1	100	1000
1 AMP RECTIFIER			
1N4001	.03	.02	.015
1N4004	.04	.025	.019
1N4007	.05	.035	.022
3 AMP RECTIFIER			
1N5401	.06	.05	.042
1N5404	.07	.055	.045
1N5408	.08	.06	.049
6 AMP RECTIFIER			
6A10	.21	.185	.156
6A100	.32	.29	.25
1 AMP SCHOTTKY			
1N5817	.20	.145	.09
1N5818	.23	.165	.10
1N5819	.25	.18	.11
3 AMP SCHOTTKY			
1N5820	.34	.255	.17
1N5821	.38	.285	.19
1N5822	.42	.315	.21
GERMANIUM			
1N34A	.10	.08	.06
1N60	.10	.08	.06
1N270	.17	.15	.13
SWITCHING			
1N914	.035	.025	.015
1N4148	.025	.02	.01
1N4448	.035	.025	.015
1 W ZENER			
1N4728	.06	.054	.047
through			
1N4764	.06	.054	.047

INTEGRATED CIRCUITS

QTY	1	100	1000
PART #			
TIL111	.38	.34	.31
MC1458	.43	.36	.29
LM1488	.47	.43	.39
LM1489	.47	.43	.39
CD4001	.29	.25	.21
CD4011	.29	.25	.21
CD4013	.37	.33	.29
CD4017	.37	.33	.29
CD4025	.37	.33	.29
CD4028	.37	.33	.29
CD4040	.47	.43	.39
CD4049	.37	.33	.29
CD4051	.44	.40	.36
CD4066	.38	.34	.31
CD4069	.37	.33	.29
CD4093	.37	.33	.29
MOC3011	.40	.36	.32
LM311	.37	.33	.29
LM324	.47	.36	.25
LM339	.48	.37	.27
LM358	.48	.37	.27
LM386	.67	.49	.33
LM393	.37	.33	.29
4N25	.54	.39	.28
4N28	.58	.41	.34
LM555	.43	.38	.33
LM556	.47	.42	.38
LM741	.43	.38	.33
74LS244	.40	.36	.32
74LS245	.37	.33	.29
74LS374	.37	.33	.29

TRANSISTORS

QTY	1	100	1000
PART #			
2N2222A	.20	.18	.15
2N3055	.55	.50	.45
2N3904	.05	.045	.035
2N3906	.05	.045	.035
2N4124	.09	.07	.045
2N4125	.09	.07	.045
2N4126	.09	.07	.045
2N4401	.05	.045	.035
2N4403	.05	.045	.035
2N5086	.09	.07	.045
2N5087	.08	.06	.04
2N5088	.08	.06	.04
2N5089	.09	.07	.045
2N5209	.09	.07	.045
2N5210	.09	.07	.045
2N5400	.12	.10	.065
2N5550	.12	.10	.065
2N5551	.09	.07	.045
BU806	1.10	.80	.70
MJE3055T	.65	.55	.44
MPSA-05	.10	.08	.05
MPSA-10	.12	.09	.06
MPSA-13	.15	.11	.075
MPSA-14	.15	.11	.075
MPSA-42	.14	.105	.07
MPSA-44	.22	.18	.12
MPSA-56	.10	.08	.05
MPSA-63	.45	.34	.22
MPSA-92	.12	.09	.06
MPSA-93	.15	.11	.075
MPSH-10	.12	.09	.06
MPSH-81	.44	.33	.21
PN2222A	.05	.045	.035
PN2907A	.05	.045	.035
TIP30	.42	.37	.32
TIP31	.42	.37	.32
TIP41	.49	.44	.39
TIP112	.56	.51	.46
TIP122	.57	.52	.47
TIP125	.53	.48	.43
TIP126	.56	.51	.46

VOLTAGE REGULATORS

QTY	1	100	1000
PART #			
7805	.48	.45	.42
7812	.48	.45	.42
7824	.48	.45	.42
7905	.61	.55	.49
7912	.61	.55	.49
7924	.61	.55	.49
78L05	.35	.31	.26
78L12	.35	.31	.26
79L05	.35	.31	.26
79L12	.35	.31	.26
LM317T	.95	.82	.68
LM350T	2.05	1.70	1.35

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QTY	50	1000	5000
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SWITCHES

QTY	1	100	1000
DIP STYLE			
4 POS.	.68	.58	.48
6 POS.	.77	.67	.57
8 POS.	.80	.70	.60
10 POS.	.95	.85	.75
TOGGLE			
SPDT	.62	.52	.40
SPDT-off	.73	.63	.49
DPDT	.69	.59	.46
DPDT-off	.86	.76	.59
PUSH BUTTON			
N. open	.28	.24	.20
N. closed	.29	.25	.21

All toggle and push button switches fit in a ¼" panel hole

LED's

QTY	1	100	1000
3MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
5MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
BI-COLOR	.29	.22	.17
BLUE	1.20	1.10	.95
BLINKER			
RED 5mm	.65	.53	.41
HOLDERS			
3mm	.10	.07	.055
5mm	.10	.07	.055

IC SOCKETS

QTY	1	100	1000
REGULAR			
8 PIN	.04	.035	.025
14 PIN	.08	.063	.045
16 PIN	.10	.08	.055
18 PIN	.11	.085	.06
20 PIN	.12	.095	.07
24 PIN	.15	.115	.08
28 PIN	.17	.13	.09
32 PIN	.20	.155	.11
40 PIN	.24	.185	.13
MACHINE			
8 PIN	.16	.135	.11
14 PIN	.28	.24	.185
16 PIN	.32	.27	.21
18 PIN	.36	.30	.235
20 PIN	.40	.33	.26
24 PIN	.48	.40	.32
28 PIN	.56	.47	.37
32 PIN	.64	.53	.42
40 PIN	.80	.66	.52
WIRE WRAP			
8 PIN	.32	.29	.26
14 PIN	.56	.51	.46
16 PIN	.64	.58	.52
18 PIN	.72	.66	.59
20 PIN	.80	.73	.65
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DX-40	128K	115.00

486 CPU

DX-40	256K	216.00
DX2-66	256K	245.00

PENTIUM™

PCI 60 MHZ	750.00
PCI 90 MHZ	816.00

FAX/MODEM BOARDS

14.4K bps	55.00
28.8K bps	189.00

HARD DRIVES

210 MB IDE	180.70
340 MB IDE	206.70
420 MB IDE	223.00
540 MB IDE	238.00
1GB SCSI	590.00

FLOPPY DRIVES

1.44MB	3½"	29.00
1.2MB	5¼"	49.50

HYUNDAI®

HCM-427E 14"

SUPER VGA MONITOR

1024 X 768 .28mm

$239.00

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3 BUTTON MOUSE	10.00
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ISA SUPER IDE I/O	18.00
ISA SCSI CARD	72.00
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VESA 2MB VGA	195.00

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with display and 200w p/s

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8"	40 oz	96dB	1w/m	250 Watts	$38.00 ea.
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All made with a double layer Kapton voice coil, heavy duty bump and vented magnets.

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Both come with complete mounting hardware, wire and sleek black mesh grills

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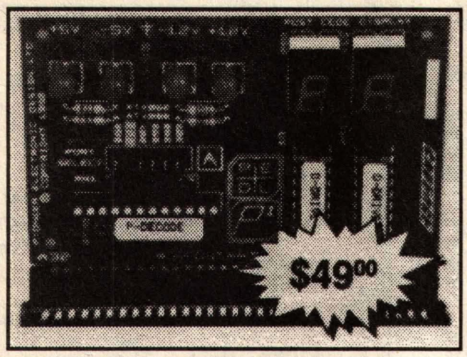

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PC DIAG 4.4 - **Selfbooting**, non bios dependent software to troubleshoot any PC from an XT - Pentium. Lets you test a system board accurately and completely, find IRQ conflicts fast, multi media testing and much much more.

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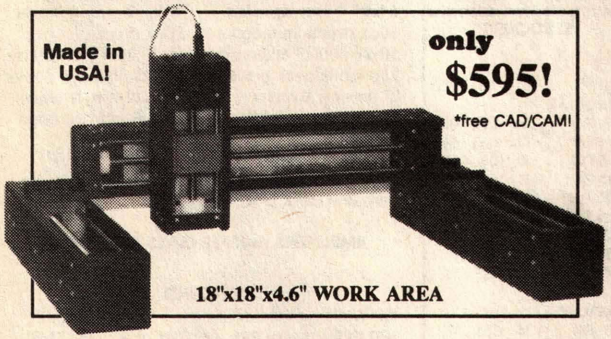
CIRCLE 147 ON FREE INFORMATION CARD

PROTOTYPE PC BOARDS!



THIS IS THE MACHINE YOU'VE BEEN WAITING FOR!

Have you ever dreamed of letting your computer prototype PC boards directly from your CAD drawings? If so, the Neuractor CNC-4+ Desktop Manufacturing System may be just the machine you need! This fourth-generation CNC machining center can automatically drill, mill and route printed circuit boards, not to mention three-dimensional products in wood, plastic and light metals DIRECTLY FROM YOUR CAD DRAWINGS! You've seen the rapid-prototyping and "Santa Claus" machines that cost thousands of dollars, but did you know that as an electronic technician you can assemble one yourself from this inexpensive kit? Utilizing patent pending technology the Neuractor CNC-4+ kit provides you with everything you need to machine products in three dimensions with a resolution of .001". All mechanical components are pre-fabricated, pre-machined, plated and painted. Includes four 83 oz/in digital CY-MOTORs, interface card, 5 amp power supply, 10 pitch steel lead screws, 4 proprietary Slide Block actuator mechanisms, 4 aluminum linear actuator channels, polished steel guide-rods, Dremel bracket, hardware, etc. (You provide Dremel MotoTool(tm) or flex-shaft router and work surface.) It's a complete kit! All you do is put it together and calibrate it! IF THAT'S NOT ENOUGH, WE'RE THROWING IN A FREE FULL-FEATURED 3D CAD/CAM SOFTWARE PACKAGE WITH EACH UNIT! Large 18"x18"x4.6" cutter travel directly from CAD-generated or scanned ASCII, DXF & HPGL plot files !. Get started by ordering your own Neuractor CNC-4+ today! ACT NOW! Kit $595 + $24.95 S/H. (For PC board routing the heavy-duty upgrade is suggested, add $149) Allow 4-8 weeks for del. U.S. CYBERLAB, 14786 Slate Gap Rd., West Fork, AR 72774 (501) 839-8293.

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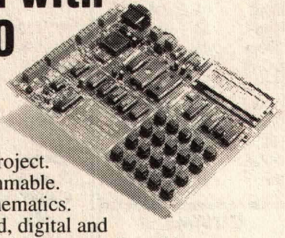

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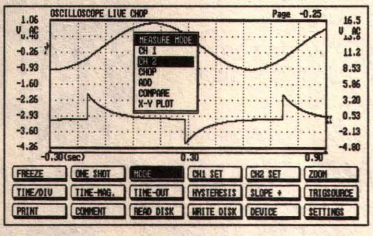
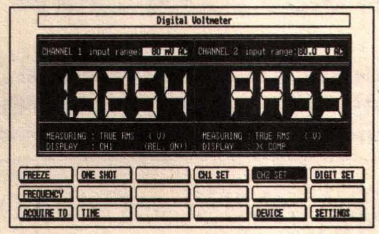
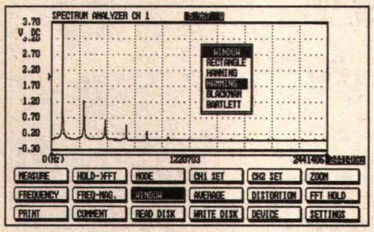

OSCILLOSCOPE LIVE CHOP
Page -0.25
MEASURE MODE
CH 1
CH 2
CHOP
ADD
COMPARE
X-Y PLOT
FREEZE
ONE SHOT
MODE
CH1 SET
CH2 SET
ZOOM
TIME/DIV
TIME-MAG.
TIME-OUT
HYSTERESIS
SLOPE +
TRIGSOURCE
PRINT
COMMENT
READ DISK
WRITE DISK
DEVICE
SETTINGS

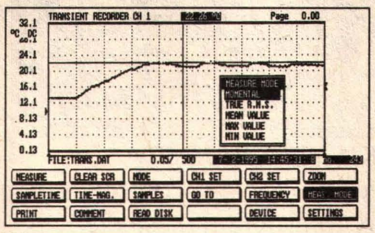
* voltmeter


Digital Voltmeter
1.3254
PASS
FREEZE
ONE SHOT
CH1 SET
CH2 SET
DIGIT SET
FREQUENCY
ACQUIRE TO
TIME
DEVICE
SETTINGS

* spectrum analyzer


SPECTRUM ANALYZER CH 1
WINDOW
RECTANGLE
HANNING
HAMMING
BLACKMAN
BARTLETT
MEASURE
HOLD->FFT
MODE
CH1 SET
CH2 SET
ZOOM
FREQUENCY
FREQ-MAG.
WINDOW
AVERAGE
DISTORTION
FFT HOLD
PRINT
COMMENT
READ DISK
WRITE DISK
DEVICE
SETTINGS

* transient recorder


TRANSIENT RECORDER CH 1
Page 0.00
MEASURE MODE
MOMENTAL
TRUE R.M.S.
MEAN VALUE
MAX VALUE
MIN VALUE
FILE:TRANS.DAT
MEASURE
CLEAR SCR
MODE
CH1 SET
CH2 SET
ZOOM
SAMPLETIME
TIME-MAG.
SAMPLES
GO TO
FREQUENCY
MEAS. MODE
PRINT
COMMENT
READ DISK
DEVICE
SETTINGS

Normally, you have to use more than one instrument to take your measurement. Together with the TiePie instruments a complete software package is delivered, in order to realize all four measuring-instruments. Your advantage is that you only need ONE measuring instrument! Moreover, you will be able to control all instruments in the same way.

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- ➡ **TP5008**
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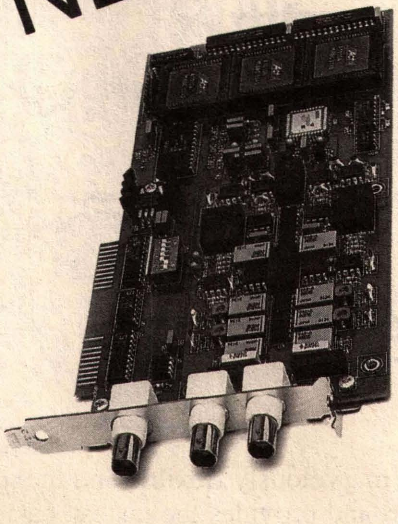
- ➡ **TP208**
  8 bits; 2 channels; 20 MHz; interface card US $998
- ➡ **AD128**
  12 bits; 8 channels; 100 kHz; interface card US $279
- ➡ **TP112**
  12 bits; 2 channels; 1 MHz; interface card US $1170

(Prices exclude applicable taxes)

VERY HIGH SPEED: TP508

NEW!!



The TP508 is a new interface card with a measuring frequency of 50 MHz!! The resolution of this card is 8 bits.

Phenomena shorter than 1 millionth of a second can still be measured well. The completely digitized triggering ensures very stable triggering with many trigger possibilities. The TP508 has an input range of 5 mvolt/div...20 volt/div (12 steps) and an auto calibration function. Since both channels may be sampled simultaneously, phase differences can be measured very accuratly. Even single phenomena can be measured since each channel has a 32 Kbyte memory. Comprehensive software is provided. US $1098

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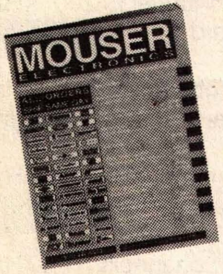

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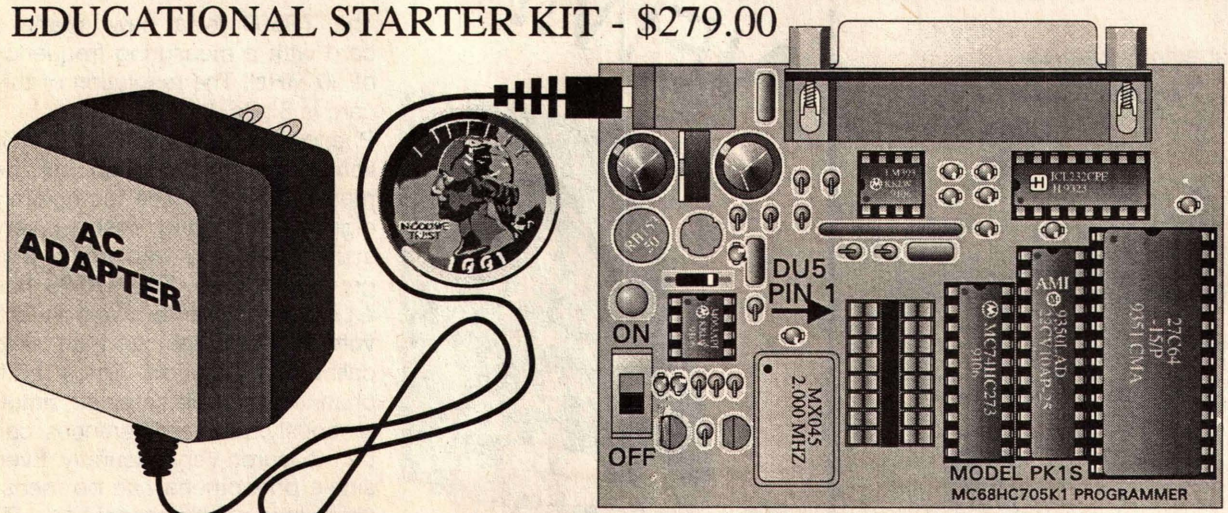

MODEL PK1S PROGRAMMER

Motorola's MC68HC705K1 is a marvelously flexible and inexpensive 16 pin microcontroller. The PK1S connects to a PC serial port and provides the fastest, easiest way to program these devices. The PK1S programmer, power supply, host PC control software and manual is $149.00. Learn how to use microcontrollers in embedded systems with the educational starter kit which includes the above plus a PC based cross assembler, Motorola technical specs and applications guide, sample programs with schematic diagrams and an erasable K1 chip for $279.00.

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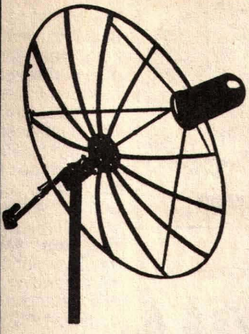
SKYVISION INC.®

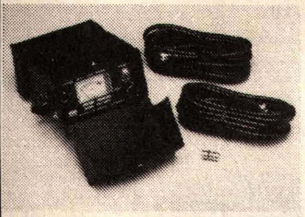
ORBITRON



Known the world over for their superior reception and picture quality, the Orbitron satellite dish features an exclusive Spinclination mount, which allows declination to be set by rotating the antenna to correct the latitude setting on the scale. Their compact shipping cartons allow these antennas to be shipped very economically to any point in the world. Let Orbitron help you expand your viewing choices.

1514001	6.7'	SX-7	Polar/Spin	$45 (S&H)	$259
1514002	8.3'	SX-8.5	Polar/Spin	49 (S&H)	319
1514004	10.0'	SX-10	Polar/Spin	63 (S&H)	449
1514005	11.7'	SX-12	Polar/Spin	84 (S&H)	649

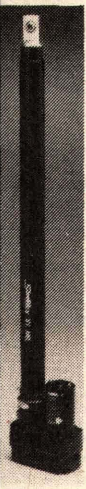
and many more...



Pico Peaker

You can now accurately aim your satellite dish to receive ***all*** the satellites using a tool the experts use. Whether installing a new system, moving your dish, or realigning your dish due to wind or frost, the Pico Peaker will save you both time and money. This unit can be used on any receiver system with block down-converted frequencies between 400 and 1450 MHz. It will also eliminate the need for those expensive service calls. The unit includes everything you need—even the cables. A *"must"* for every satellite enthusiast.

900038 Pico Peaker S&H $5 $89.95



Superjack Actuators

Is your actuator no longer doing its job because of wear and tear? As the hardest working part of your satellite system, the actuator must move your dish from east to west across the entire satellite belt. Each time you change satellites, your actuator sends pulses to the receiver telling the receiver when to stop moving the dish. Most older actuators sent only 10-16 pulses for each inch of travel, which may not be enough to stop the dish at the maximum signal strength. Today's new heavy duty actuators with high resolution reed sensors send 48 pulses per inch of arm travel.So if your old actuator is getting tired, let a new SuperJack insure the finest picture possible.

18" arm	1019018	S&H $15	$ 89
24" arm	1019026	S&H $16	139

Satellite Television

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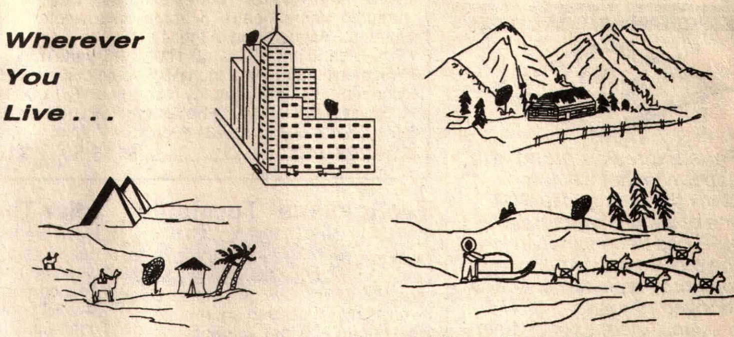

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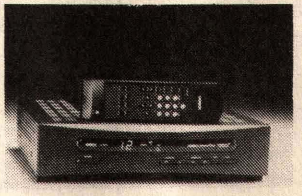

Ultra

The Ultra is Uniden's newest, smallest fully-integrated C/KU receiver ever. This unit includes the ability to control dish movement and is ready for an optional internal program decoder. The Ultra comes preprogrammed for 49 satellite positions and allows you to add satellites as they are launched. Move directly to the satellite by entering the abbreviation from the included infrared remote control. Forty programmable favorite channels can be accessed immediately from your easy chair. Run across something you don't want your kids to see? Just touch a button and eliminate that channel from their access. A complete variety of color menus allow you to control everything from your remote control. The Uniden Ultra is an ideal receiver to get you started in Direct-To-Home Satellite TV.

4527008 Ultra S&H $22 $379.00

The UST 4600 sets a standard in value and performance for home satellite receivers. This unit features automatic satellite programming, 160 favorite channels can be instantly recalled for easy access. All 160 can be changed or updated at any time. This IRD features a stereo processor, enabling you to tune both left and right channels for a full stereo effect from over 100 radio stations found in satellite. The QuikTune feature quickly optimizes the satellite picture for the sharpest image. The 4600 offers other features including IR/UHF remote, 55 satellite position memory and direct satellite access. The versatility makes this an excellent choice.

4527009 UST4600 S&H $22 $499.00

UST 4600

UST 4900

The Uniden UST 4900 is one of the most sophisticated satellite television receiver systems available today. This receiver will open your home to the universe of satellite viewing and is designed to be one of the most user-friendly IRDs available anywhere. Sophisticated microcomputer technology brings in crystal clear audio and video broadcasts with a minimum of user effort. The UST 4900 front display features easy-to-read icons that show you vital information including satellite, channel, polarity, timer status, antenna position and much more. This receiver is capable of storing the positions of the satellites, as well as the tuning details for each channel. The picture-in-picture feature allows you to view two video sources at the same time. You can have it all, including advanced technology and lasting quality, with the UST 4900.

4527010 UST4900 S&H $22 $689.00

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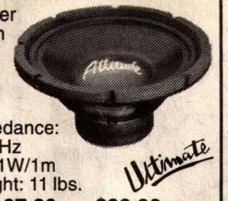
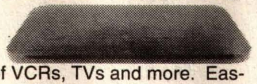
Ultimate 12" AU1290 Dual VC Subwoofer



Just one listen to this 12" dual voice coil subwoofer from Ultimate will leave no doubt that this sub can shake, rattle, and roll! Works extremely well in car audio, home theatre, or satellite/subwoofer systems. Handcrafted in the U.S.A.
◆Power handling: 350 watts RMS/500 watts max ◆Voice coil diameter: 2 inch ASV voice coil ◆Impedance: 6 ohms per coil ◆Frequency response: 18-1,000 Hz ◆Magnet weight: 90 oz. ◆F_S: 21 Hz ◆SPL: 88 dB 1W/1m ◆V_{AS}: 5.9 cu. ft. ◆Q_{TS}: .421 ◆X_{MAX}: .41" ◆Net weight: 11 lbs.

#EN-292-710 .... $\$115.50_{(1-3)}$ $\$107.80_{(4-11)}$ $\$99.90_{(12-UP)}$

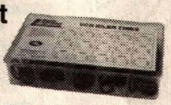
Technicians' Turntable



Turntable to speed repair of VCRs, TVs and more. Easily turn unit for convenient repair. Holds up to 200 lbs. Dimensions: 20" W x 15" D x 1-1/8" H. Black pebbled surface. Includes 4 anti-skid adhesive feet. Net weight: 9 lbs.

#EN-360-427 $\$28.50_{(1-3)}$ $\$23.80_{(4-UP)}$

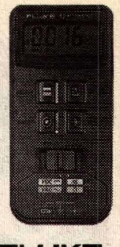
Idler Tire Kit



Have the tire you need in stock when you need it. This comprehensive kit contains 180 of the most commonly used tires in an easy-to-use case and a cross reference for 32 manufacturers crossing to over 600 VCR model numbers. A $400.00 retail value. Net weight: 1-1/2 lbs.

#EN-400-900 .... $\$39.95_{KIT}$

Fluke Model 12 Multimeter



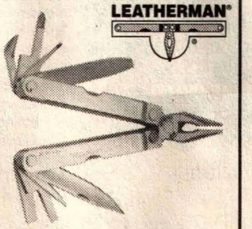
The Model 12 compact digital multimeter combines basic features, high performance, low cost and Fluke reliability. It was designed for first level electrical and electronic troubleshooting. Includes 9V battery, operating manual, and test leads. Two year manufacturer warranty.

FLUKE.

Features: ◆Measures AC/DC volts, ◆4000 count digital display, ◆Autoranging, ◆Automatic shut off, ◆Diode and continuity test, ◆1.5% accuracy, ◆V Chek™ overload protection mode, ◆Capacitance check to 999 uF, ◆0.9% accuracy, ◆Min/Max Record with time stamp, ◆Input change alert, ◆Continuity Capture™ (captures and records intermittent opens and shorts), ◆Net weight: 1 lb.

#EN-392-020 .... $92.50

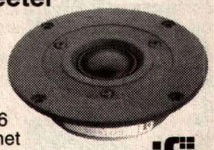
Leatherman Tool



The Leatherman tool is an extremely versatile and durable compact toolchest you can hold in your hand ... contains 12 useful tools in one! Needlenose pliers, regular pliers, awl, Phillips screwdriver, three slotted screwdrivers, can and bottle opener, wire cutters, file, knife, and 8 inch ruler. Made of only the highest quality 100% stainless steel. Includes sturdy leather sheath. 25 year manufacturer warranty. Net weight: 5 oz.

#EN-360-990 .... $\$39.95_{(1-3)}$ ..... $\$37.50_{(4-UP)}$

Vifa D25TG-05 1" Poly Dome Tweeter

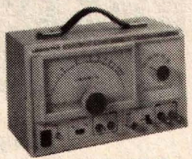


Excellent performance at a moderate price. This ferro fluid cooled 1" poly dome tweeter features a high loss diaphragm, user replaceable voice coil assembly, and high power handling.
◆Power handling: 100 watts RMS/140 watt max ◆Nominal impedance: 6 ohms ◆DC resistance: 4.6 ohms ◆Frequency range: 3,000-24,000 Hz ◆Magnet weight: 8.5 ozs. ◆F_S: 1500 Hz ◆SPL: 90 dB 1W/1m ◆Net weight: 1-1/4 lbs.

vifa

#EN-264-502 .... $\$18.50_{(1-3)}$ $\$16.80_{(4-11)}$ $\$15.45_{(12-UP)}$

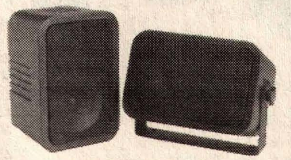
Audio Generator



Square wave and sine wave generator useful for a variety of audio applications. Generates 10 Hz to 1 MHz in 5 ranges. Output voltage: 8V RMS sinewave, 10V p-p squarewave. +/-3% dial accuracy. Output impedance: 600 ohms. Synchronization: +/-3% of oscillation frequency per VRMS. Dimensions: 6"H x 10"W x 5"D. Includes test lead, AC power cord, and manual. One year manufacturer warranty. Net weight: 6 lbs.

#EN-390-620 .... $119.00

Mini Weatherproof Speaker System



These mini weatherproof speaker cabinets are made from high impact polypropylene which is completely weather sealed making these perfect for indoor or outdoor use. These great sounding mini speakers feature a 5" polypropylene cone woofer and a mylar dome tweeter. Ideal for use as extension speakers or for surround sound. Small size blends easily into any decor. Frequency response: 130-20,000 Hz. 8 ohm impedance: 30 watts RMS, 60 watts maximum power handling capability. Mounting brackets included. Dimensions: 8" (H) x 5-1/2" (W) x 4-1/2" (D). Net weight: 10 lbs.

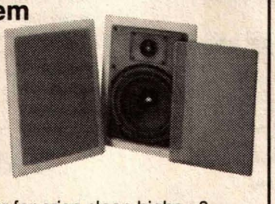
#EN-310-020 (Black)
#EN-310-025 (White) **..................... $\$79.95_{(1-3\ PRS)}$ ... $\$74.80_{(4\ PRS-UP)}$**

Professional Strobe Light

No top notch lighting display is complete without a powerful, high speed strobe light. This professional unit features an ultra bright xenon flash tube, reflective bowl, variable speed control, and on/off toggle switch. A 1/16" clear plexiglass cover is mounted on brass stand-offs to protect the flash tube assembly. Includes adjustable mounting bracket. Dimensions: 9-1/2" (W) x 8-5/8" (H) x 6-7/8" (D). Net weight: 7 lbs.

#EN-243-072 .... $92.80

6-1/2" Two Way In-Wall System

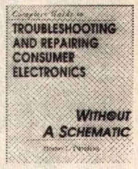


This is our most popular in-wall. You won't believe how good these really sound. Big enough to produce great home theater sound and still fit everyone's budget. Put a pair in every room of your house. Great for front or rear speakers in your surround system. The 6-1/2" polypropylene woofer and 1" textile dome tweeter were specially designed with home theater in mind. The crossover network utilizes a mylar capacitor for crisp clean highs. 3 piece design make installation in new or existing walls a snap. Textured ABS frame and steel mesh grill are spray paintable to match (or blend into) any decor. Speaker front plate is "blacked out" for cleaner "through grill" appearance. System comes with speaker assembly, removable metal grill, heavy steel backer plates, screws and hardware, hole cut-out template, paint mask, and detailed installation instructions.

Specifications: ◆6-1/2" polypropylene cone woofer with poly foam surround. ◆1" textile dome tweeter/midrange. ◆8 ohm impedance. ◆3 component L/C crossover network. ◆Frequency response: 50-20,000 Hz. ◆Power handling capability: 60 watts RMS/100 watts max. ◆Sensitivity: 89 dB 1W/1M. ◆Overall dimensions: 8-1/2" W x 12" L x 3-1/2" D. ◆Hole size: 7-1/4" x 10-3/4". ◆Fits into standard 2" x 4" wall. ◆Net weight: 12 lbs. per pair.

#EN-300-036 .... $\$104.95_{(1-3\ PRS)}$ $\$96.50_{(4-11\ PRS)}$ $\$85.50_{(12\ PRS-UP)}$

Troubleshooting And Repairing Consumer Electronics Without A Schematic



A common problem faced by repair technicians is having to troubleshoot electronic equipment without a schematic. With hundreds of illustrations, this indispensible guide demonstrates how to locate, test, and repair amplifiers, TVs, CD players, radios, power supplies, and more. Written by Homer L. Davidson. 320 pages. Copyright: 1994. Net weight: 1-1/4 lbs.

#EN-500-305 .... $\$22.95_{EACH}$

Isotip Butane Soldering Iron

The ideal soldering iron for field repairs where no AC power is present. Operates for up to 100 minutes of continuous soldering per refill. Uses standard butane (not included) available at most stores. Tip temperature is adjustable up to 1067° F. Iron also comes with a torch attachment which easily screws on in place of the soldering tip. As a torch, one refill will provide up to 1 hour of continuous flame. Temperature is adjustable up to 2372° F. A protective cap with a built-in striker and 2.4mm tip are included. Limited one year warranty.

ISOTIP
cordless soldering iron

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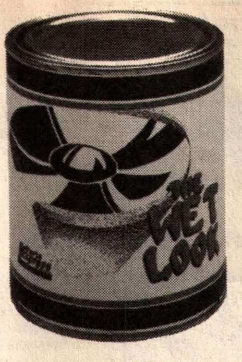
3-In-1 Universal Remote

This remote will operate any remote controlled cable box, TV or VCR at just a fraction of the cost of a factory replacement! This unit is already preprogrammed to include the most common codes. It is attractively styled, durable, and easy to set up and operate. The manufacturer even offers a toll free consumer help line to answer questions and provide customer assistance. Requires 2 AAA batteries (not included).

#EN-180-565 .... $\$11.95_{(1-9)}$ $\$9.95_{(10-UP)}$

The Wet Look™



The Wet Look™ is a new generation of high gloss polymers formulated especially for the speaker industry. This superior coating provides a protective "coat of armor" for your paper cone speakers. A special U/V inhibitor has been added to reduce the decaying effects of the sun's ultraviolet rays. The Wet Look™ makes paper cones resistant to water, humidity, sun, and salt. Best of all, it's easy to apply and cleans up with soap and water. 1 pint can.

#EN-340-510 (Clear) .... $\$8.95_{EACH}$

#EN-340-512 (Black) .... $\$8.95_{EACH}$

72 Pin Game Cartridge Connector

Quality replacement for the game cartridge connector used in Nintendo Entertainment Systems (NES). Repeated loading and removal of game cartridges damages the connector contacts and produces symptoms such as a flashing blank screen or distorted picture. Revitalize your unit by replacing the game connector. It's simple; there is no soldering required and only a phillips head screwdriver is needed to complete installation in minutes! Our replacement connector has gold plated game contacts for long life, superior conductivity, and resistance to oxidation. One year warranty.

#EN-091-900 $\$8.95_{(1-9)}$ $\$7.95_{(10-UP)}$

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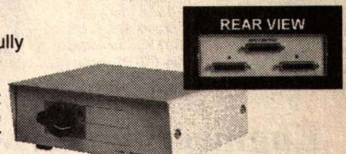
"Copper tip" design standard 1/4" phone plug. Unsurpassed quality ensures low noise and high conductivity connection. All metal/nylon construction with external solder connections. Insulator sleeve included. 5/16" ID barrel. Made in the U.S.A.

GH Industries

#EN-092-200 (Mono) .... $\$2.25_{(1-9)}$ $\$1.95_{(10-49)}$ $\$1.75_{(50-UP)}$

#EN-092-206 (Stereo) .... $\$3.25_{(1-6)}$ $\$2.90_{(10-49)}$ $\$2.65_{(50-UP)}$

RS-232 A-B Switch

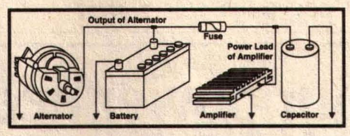


High reliability rotary type switch. Fully shielded, heavy gauge steel construction with gold plated connectors. All pins switched through (except ground). Used to switch multiple printers or computers. Full one year warranty. Net weight: 1-3/4 lbs.

#EN-130-010 .... $\$9.95_{(1-2)}$ $\$8.95_{(3-9)}$ $\$7.95_{(10-UP)}$

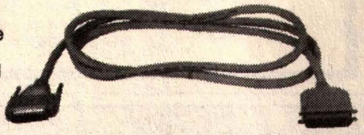
Car Stereo Power Supply Capacitors

Most car amplifiers' power supplies simply lack the capability to produce large amounts of instantaneous power. These computer grade, car stereo capacitors work by storing energy and supplying, on demand, a quick burst of energy to the power amplifier. The result is tremendous bass punch and dramatically improved transient response. Feature gold plated terminals.



Part #	Value	Voltage	Dimensions	Weight	Price (1-15)	Price (16-UP)
EN-029-1000	1,000,000 uf	16 VDC	3"(dia.) x 8-1/2"	3 lbs.	$59.80	$52.80
EN-029-1005	1,000,000 uf	20 VDC	3"(dia.) x 8-1/2"	3 lbs.	79.80	73.50

Printer Cables



25 pin male RS-232 to 36 pin male Centronics connector. Fully shielded and molded cable with all 25 conductors connected. Convenient thumbscrew hardware on the RS-232 connector.

Part #	Length	Price (1-9)	Price (10-49)	Price (50-UP)
EN-130-220	6 ft.	$4.50	$3.90	$2.90
EN-130-225	10 ft.	5.50	4.95	3.75
EN-130-227	15 ft.	8.50	7.90	5.90
EN-130-228	25 ft.	10.90	9.50	7.90
EN-130-229	50 ft.	19.80	17.50	14.90

Video School

Video School videos make it easy for anyone to comprehend the complex operations of VCRs, camcorders, and more. From How to Clean VCRs for the video rental store, to Minor Camcorder Repair for the advanced service shop. There is something for everyone! These tapes also make great new employee orientation videos.

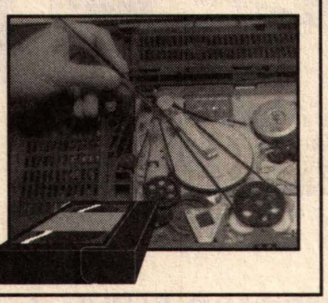
Electronic Video Library

Save over $25.00 by purchasing this complete library of six Video School instructional videos. You'll receive VCR 1-How To Clean VCRs, VCR 2-Minor VCR Repair I, VCR 3-Minor VCR Repair II, VCR 4-Common VCR Malfunctions, VCR 5-Diagnosing Video Heads, and Cam 1-Minor Camcorder Repair. Net weight: 5 lbs.

BUY THE SET AND SAVE!

#EN-505-550 .... $\$195.00_{EACH}$

Part #	Description	Price
EN-505-010	VCR 1, How To Clean VCRs	$28.95
EN-505-020	VCR 2, Minor VCR Repair I	38.95
EN-505-025	VCR 3, Minor VCR Repair II	38.95
EN-505-050	VCR 4, Common VCR Malfunctions	38.95
EN-505-035	VCR 5, Diagnosing Video Heads	38.95
EN-505-030	VCR Test Patterns Alignment Tape	23.95
EN-505-040	Cam 1, Minor Camcorder Repair	38.95
EN-505-085	Microwave Oven Repair	39.95
EN-505-080	Nintendo Repair and Maintenance	33.95
EN-505-090	IBM Compatible Computer Assembly	28.95
EN-505-095	Hi-Fi Alignment Test Tape	29.95



Skew Driver Pro

This unique tool features a gear driven offset bit driver to be used in tight spots or where conventional screwdrivers just won't fit. Includes 1/4" and 3/16" slotted bits, T15 Torx® bit, and 2 phillips bits that are contained in the handle compartment. Can also be used with a 1/4" electric drill. Made in the U.S.A. Net weight: 1/2 lb.

#EN-360-178 $\$39.90_{(1-5)}$ $\$34.50_{(6-UP)}$

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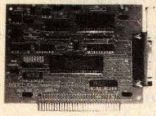
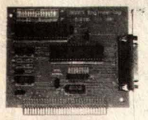
ANA100 Analog I/O .... $ 99



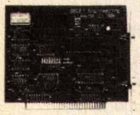
- 8 Channel 8-Bit 0 to 5 Volt input
- 14 TTL I/O lines
- Analog output
- 400 Khz sampling

DIG100 Digital I/O.......... $ 39



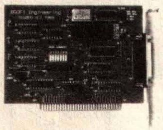
- 8255 PPI
- 24 or 48 TTL I/O Lines
- Selectable Base Address

ANA150 Analog/Counter... $ 89



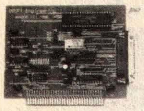
- 8 Channel 8-Bit 0 to 5 Volt input
- 3 16-Bit Counters
- 400 Khz sampling

DIG200 Counter I/O........ $ 79



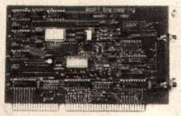
- 3 16-Bit Counters
- 8-Bit input port
- 8-Bit output port
- Selectable Clock frequency input

ANA200 Analog I/O............. $ 79



- 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- 100 Khz sampling
- 24 TTL I/O lines

ANA201 Analog .... $ 129



- 8 Channel 12-Bit
- x1, x5, x10, x50 Programmable channel gain
- 100 Khz sample

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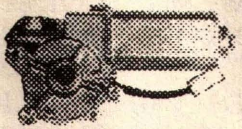

12VDC. Originally for automotive electric windows. (95M002) **$14.95 each**

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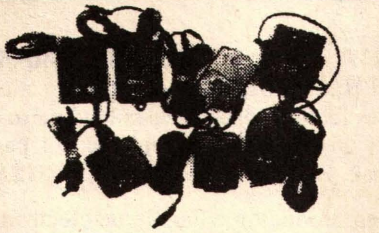
Studioline Stereotrack II Cable TV Adapter

Separates stereo signals from the cable TV input, feeds TV signals to TV/VCR tuner and stereo signals to FM (either RF or fixed/variable level audio). Inside are hundreds of useful parts which may be removed for audio/RF projects. Controller board has CPU and socketed EPROM as well as Mitsumi varactor tuner, cable/FM separator board, regulated power supply subassembly, channel select board, and stereo separation output board. Black metal case, 14" x 10" x 3". Sold for experimental purposes only. With documentation. (92V020) **Two for $39.95**



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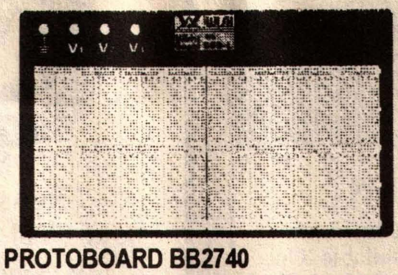
A random selection of assorted voltages and current ratings. (94E004) **10 for $14.95**



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9.84" x 6.3" x 1.22". Six distribution strips, 340 distribution holes. Four terminal strips, 3200 terminal holes. Four binding posts, 140 jumper wires. (BB2740) **$36.00 each**

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Both windings measure 1.0 mH with a DC resistance of 0.2 Ohms. If used as an inductor for a crossover network, both channels will be coupled together. Good for an auto subwoofer system. (95N001) **$1.99 each**

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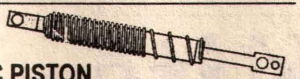

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The Electric Piston is an amazing, fully integrated shape memory alloy actuator. Power it up and this strong, compact device (about the size of a jumbo crayon) pulls with up to one pound of force and contracts by 20 mm (¾") - twenty percent of its length! No compressors or hydraulic fluids, just electricity.

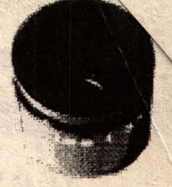
Capable of lifting 45 times its own weight, the Electric Piston has an incredibly smooth and silent action. It has built-in protection from overstrain, and mounting holes for easy installation in your devices. Typical activation requires just 1 Volt at five Amps for two seconds.

PHYSICAL - Length, relaxed: 100 mm. Length, contracted: 76 mm. Maximum diameter: 9 mm. Mass: 10 grams. Net stroke (no load): 23 mm. Net stroke (450 gram load): 19 mm.

ELECTRICAL - Total electrical resistance: 0.2 Ohm. Typical power: 5 Amps at 1 Volt. Typical contract time: 2 seconds. Typical relax time: 8 seconds. Typical cycle rate: 6 cycles per minute.

THERMAL - Contraction finish temperature (Af): 90° C. Relaxation finish temperature (Mf): 65° C. (3-137) **$7.95 each**

PRECISION EYEPIECE



21mm f:3.5. Four coated glass lenses in black aluminum case measuring 1.15625" long by 1.0" diameter. Excellent correction of all aberrations for an angle of 35 deg. without vignetting. Resolution in focus is 385 lines/mm when the image of object is in focus (D=6mm), or 500 lines/mm when object is in focus (numerical aperature 1.41). Possible applications include: objective lens for scanners; photographic objective enlarging nearly 10X; objective for a hand-held microscope, enlarging from 30X to 120X (numerical aperature=1.41); lens working with light sensor or emitter as a precise focusing element; or lens for shaping a laser beam. (92L031) **$12.50 each**

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For all Atari 8-bit computers. Package includes: printer, power supply, software, pens, paper and interface cable. These are new units in factory sealed boxes. (94C037) **$14.95 each**

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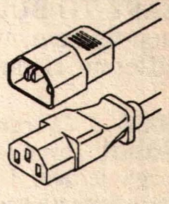
1' MONITOR POWER CABLE

If your monitor has a permanent AC power cord attached, plug it into this adapter and then into the back of your computer. (94W002) **$2.95 each**

MONITOR POWER CABLES



If your monitor has a removable power cable, replace it with this one that plugs into your computer, allowing monitor to power up with computer.

- **Six Feet** (94W003) **$3.49 each**
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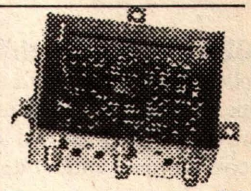

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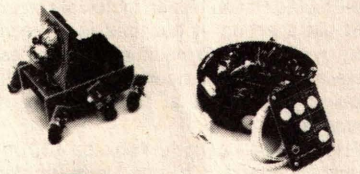

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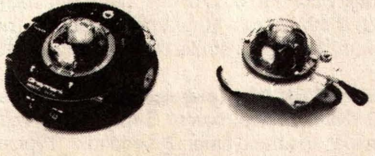

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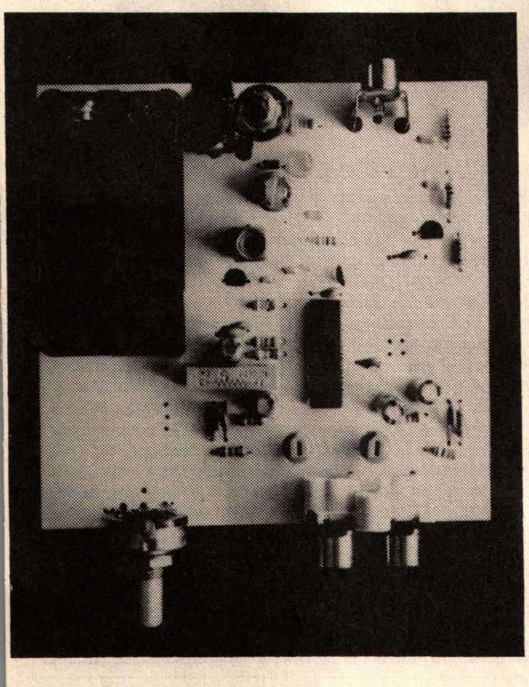

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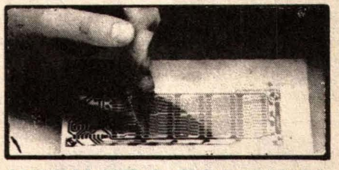

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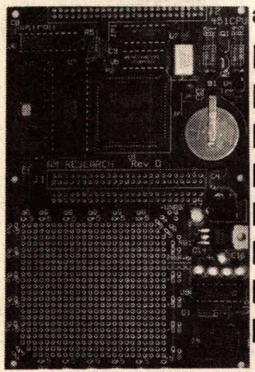

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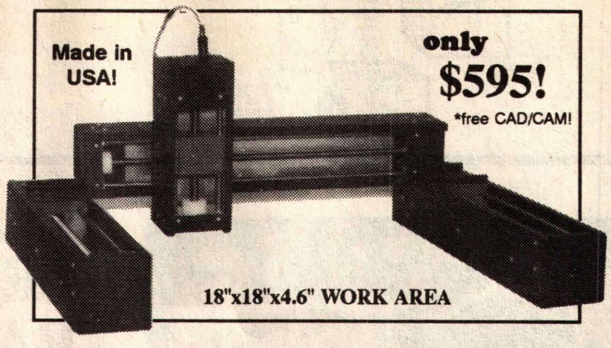

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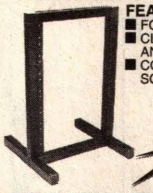

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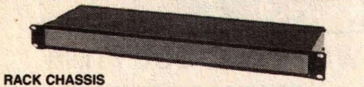

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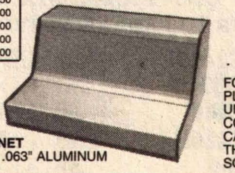

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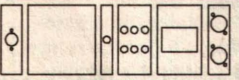

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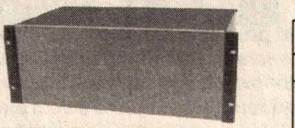

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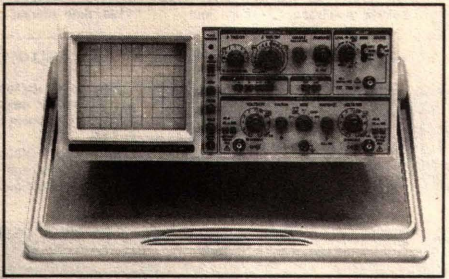

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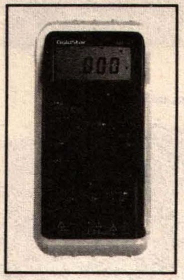

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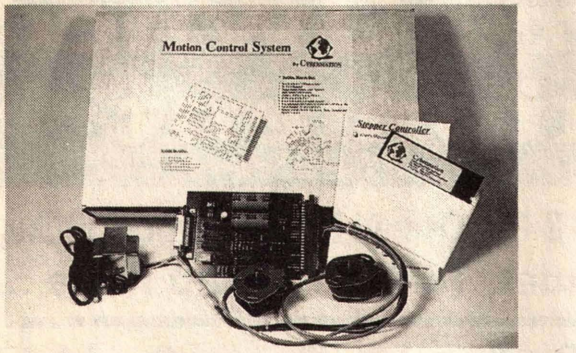

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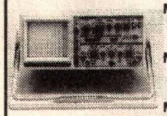
C20 Hard Case for 25,27	$15
C75 Test Lead Case	4
C95 Scopemeter Soft Case	82
C97 Scopemeter Hard Case	45
Y8205 8010, etc. Soft Case	27
80PK4 Air Temp. Probe	32
80TH Touch/Hold Probe	71

DISCONTINUED ITEMS
(All new, No returned goods)

Model 8020B Dig. MM	$207
Model 8021B Dig. MM	168
80T-SP Surf.Temp.Probe	76
AC85 Large Allig. Clip	6
PV500 Press./Vac. Snsr.	284
Y9134 Allig. Clip (10 pk)	13

Call for BEST PRICES on other Fluke models and accessories.

GOLDSTAR **OSCILLOSCOPES**

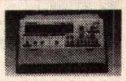


Model OS-9100P $995
Compact, 100MHz, dual-trace.
Model OS-904RD $695
40MHz, dual-trace, cursors w/CRT readout
Model OS-9020A $395
20MHz, dual trace

POWER SUPPLY

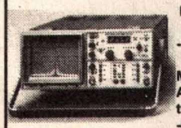
GP-4303D
0-30V, 0-3A, digital V/I display, <1.5mV ripple, curr. limit. $199

COUNTER / TIMER



MODEL FC-2130U
Freq. 0.2Hz-1.3GHz, period, ratio, totalize, time interval $329

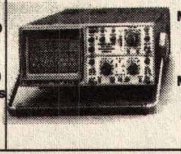
HAMEG **SPECTRUM ANALYZER**



Model 5005 $1,090
0.1-500MHz, dig. R/O -100,+13dbm. sens.

Model 5006 $1,470
As above but includes tracking genrtr., -50,+1 dbm.

HAMEG **OSCILLOSCOPES**



Model HM303 $568
30MHz, dual-trace, component tester.

Model HM205 $1,065
20MHz, dual trace, analog/digital.

800-554-8305
FAX 404-772-9780
Local/Technical
404-772-9811

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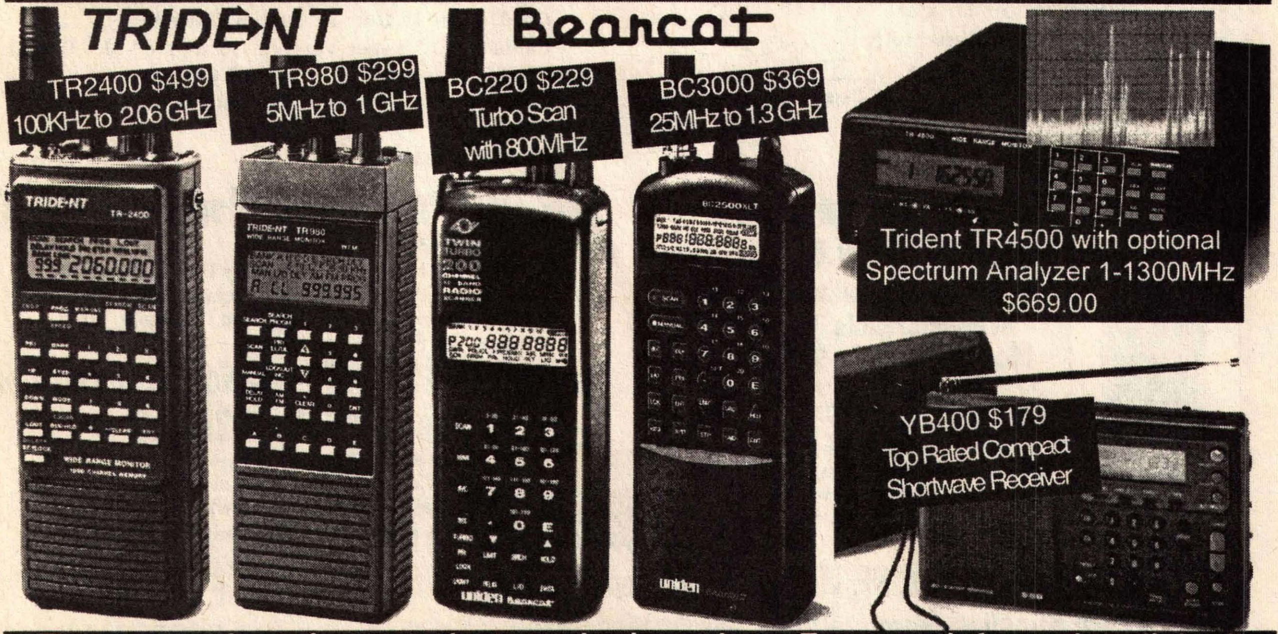

These are a few of our products and price values. For more information dial toll free or use our BBS, or get instant specs & info. from our fax back service.

Toll Free, 24 Hours! For orders or for tech support, dial our 800 number. For Fax Facts Instant catalog sheet service, dial 317 849 8683. Computer BBS & Fax/Modem,317-579-2045. Mastercard, Visa, Checks, Approved P.O.'s & COD (add $5.50) & AMEX, Discover. Prices, specs and availability subject to change. Ground shipping and handling charge $6.95

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OUR SPECIAL OFFER

Hewlett-Packard 6289A Power Supply
0 to 40 VDC, 0 to 1.5 ADC
$375.00
New

Quality Reconditioned Test Equipment

Fluke 5100B Calibrator

Multifunction calibrator for analog and digital multimeters to 4½ digits, direct or alternating voltage or current plus resistance. Has options 03, 05.

$8000.00

Hewlett-Packard 3336B Synthesizer/Level Generator

This level generator is an excellent precision source from 10 Hz to 20.9 MHz, frequency resolution of .001 Hz, level accuracy within .15 dB over full range, AM and phase modulation. Fully programmable over HP-IB, harmonics down more than 5 dB.

$650.00

Hewlett-Packard 3586B Selective Level Meter

Makes carrier measurements to 32.5 MHz, voice channel measurements from 50 Hz to 100 kHz, can use the 3336B Level Generator as an automatic tracking generator. Includes options 001, 003, & 004.

$850.00

Buy both together as a set for $1300.00

Hewlett-Packard 105B Quartz Oscillator

High spectral purity, excellent stability, well-buffered outputs, aging < 5 x 10^{-10} per day. High reliability, built in 6 hour standby battery.

$1950.00

Tektronix 2336 100 MHz Oscilloscope

DC to 100 MHz bw, 5 mV/div to 5 V/div, 5 ns/div sweep rate, Δ time on the flip top cover.

$1250.00

Wavetek 2001

Sweep Generator, 1 to 1400 MHz, RF output of +10 to -80 dBm in 1 dB steps.

$975.00

Tektronix 475A Oscilloscope

250 MHz bw, dual channel, 5 mV/ div sensitivity, 1 nS/ div sweep rate. Includes 2 probes.

$975.00

Hewlett-Packard 3582A Spectrum Analyzer

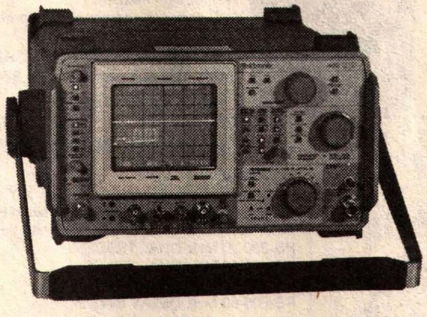
Frequency range, .02 Hz to 25.5 kHz, dual-channel, band selectable analysis for 0.02 Hz resolution, sensitivity -120 dBV, digital trace storage. Option 01.

$2850.00

Tektronix 492 Spectrum Analyzer

50 kHz to 21 GHz, 80 dB dynamic range, amplitude comparison in 0.25 dB steps. Options 01, 02, & 03.

$8850.00



Tektronix 496P Programmable Spectrum Analyzer

1 kHz to 1.8 GHz, amplitude comparison in 0.25 dB steps, 80 dB dynamic range, automatic phase lock, GP-IB fully programmable.

$8500.00

Wavetek 270 Function Generator

.01 to 12 MHz, programmable, GPIB, 200 stored settings. Option 002.

$950.00

Hewlett-Packard 432/8478B Power Meter with Thermistor Mount

10 MHz to 18 GHz, 10μW to 10 mW full range, digital display.

$850.00

Hewlett-Packard 11975A Microwave Amplifier

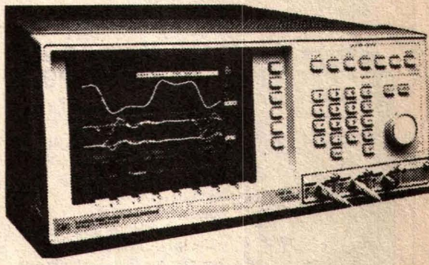
General purpose, leveled microwave amplifier, 2 to 8 GHz, frequency range.

$3000.00

Hewlett-Packard 54100A Digitizing Oscilloscope

1 GHz bw, 350 ps rise time, 100 ps/ div time base, 40 ms/sec maximum digitizing rate, pre-trigger viewing, logic triggering, includes 3 HP 54002A 50Ω BNC input pods.

$6000.00



Hewlett-Packard 8505A Network Analyzer with 8501A & 8503A

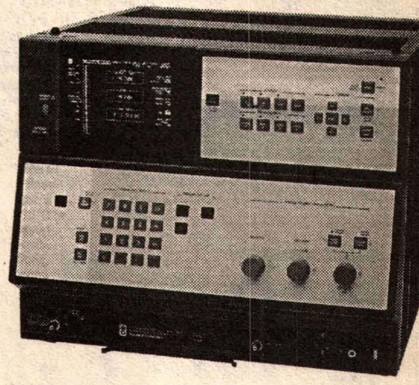
500 kHz to 1.3 GHz, 100 dB dynamic range. Includes 8501A storage normalizer and 8503A S parameter test set.

$5000.00

Wandel & Goltermann TSA-1 Transmission System Analyzer

Frequency range of 100 Hz to 180 MHz, spectrum analysis, selective level, demodulation and phase jitter.

$2250.00



Above unit with Network Analyzer.

$2750.00

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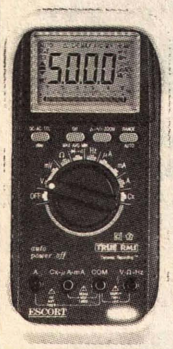
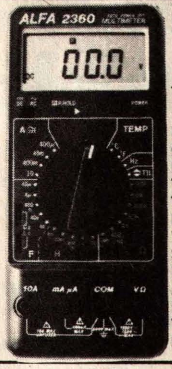


DMM 89 $199.95

Most Advanced DMM

All Purpose & Communication

-80.7 to 81.4 dBm with 4Ω -1200Ω
20 reference impedances
True RMS
Frequency counter: 0.01Hz-10MHz
Capacitance: 1pF-50,000µF
Measure AC volt to 20kHz
5000 counts, 0.1% accuracy
Auto/manual range, fast bar graph
Min/Max/Ave/DH/Relative/Zoom
Auto power off
Input warning
Splash proof
Volt, amp, ohm, logic, diode, continuity
Ruggerdized case
Rubber holster included

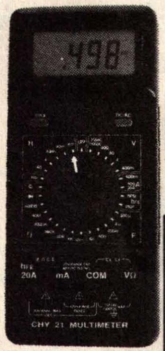


DMM 2360 $119.95

DMM+LCR Meter

Very Versatile DMM

Inductance: 1µH-40H
Capacitance: 1pF-40µF
Frequency: 1Hz - 4MHz
Temperature: -40-302 °F
TTL Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off
Ruggerdized case.
Temperature probe included
Rubber Holster $8.00

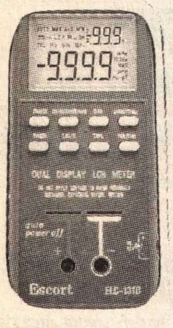


DMM 20 $74.95

Inductance: 1µH-40H
Capacitance: 1pF-200µF
Frequency: 1Hz-20MHz
Volt, amp, ohm, diode,
20 Amp AC/DC current
Transistor HFE
Continuity, duty %
Peak hold/Max
Ruggerdized case
Rubber holster $8.00

Full line of DMMs, economy, compact, ruggerdized, solar cell, automotive, heavy duty, industrial, starts from $15.95

Fluke Multimeter	
Fluke 12	$84.95
Holster C-10	$10
Fluke 70 II	$67.5
Fluke 73 II	$94
Fluke 75 II	$129
Holster C-70	$16
Fluke 77 II	$149
Fluke 79 II	$169
Fluke 29 II	$169
Fluke 83	$225
Fluke 85	$259
Fluke 87	$287
Fluke 97 Scope Meter	$1785



LCR Meter 131D $229.95

Most Advanced LCR

Dual display:L/Q or C/D
Inductance: 0.1µH-1000H
Capacitance:0.1pF-10,000µF
Impedance:1mΩ-10MΩ
0.7% basic accuracy
Auto/manual range
Dissipation factor & Q factor
Serial & parallel mode
Relative mode for comparison and to remove parasitics
Statistics, tolerance,
Best for design, incoming testing & production
SMD and chip component test probe $25.00

02.6
GW LCR-814 LCR METER

LCR Meter 814 $189.95

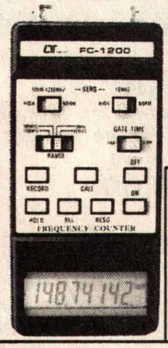
Best Resolution LCR

Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics
Best for high frequency RF
SMD and chip component test probe $25.00

LIMITED QUANTITY SPECIAL

DIGITAL LCR METER $74.95

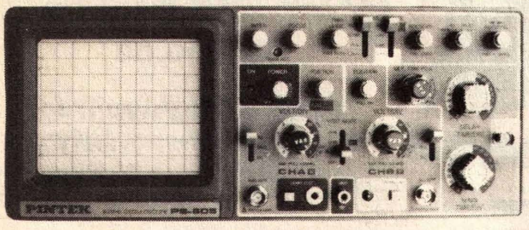
0.1pF, 1µH, 10mΩ resolution



Frequency Counter FC-1200 $129.95

Frequency:0.1Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
Deluxe case $5.00

Also Available:
AC/DC clamp meter,Light meter, Thermometer, pH meter, High voltage probe, Digital caliper, Anemometer, Electronic scale, Force gauge,Tachometer, Stroboscope, Humidity & EMF adapter, Sound level meter, Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
PS-605 60 MHz DELAY SWEEP	$769.95

Scope Probe: 60MHz x1, x10 $15, 100MHz x1, x10 $22
250MHz x1, x10 $29, 250MHz x100 $39

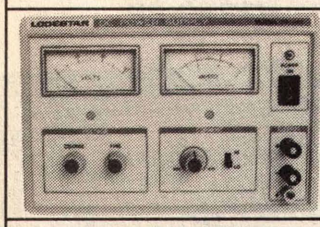
Digital Storage Scope

DS-203 20MHz, 10M Sample/sec $729.95

DS-303 30MHz, 20M Sample/sec $849.95

DS-303P with RS-232 interface $1,049.95

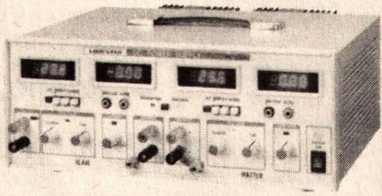
Switchable between digital and analog modes
2 K word per channel storage
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter control



DC Power Supply PS-303 $159.00

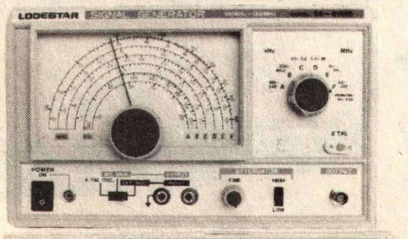
0-30 VDC , 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A



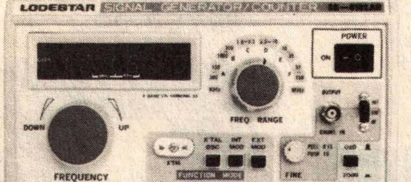
DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF SIGNAL GENERATOR SG-4160B $119.00

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms



RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
6 digit frequency counter 1Hz-150MHz for internal and external sources Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
AM Modulation
Gated Burst, Voltage Control Generator
Generator Control Voltage & 6 digit counter 1Hz-10MHz for internal & external sources

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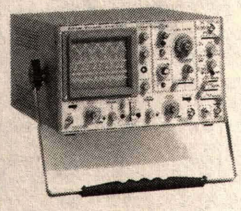
100 MHz Cursor Readout Scope
4 ch, 8 traces OS-6101 $1,499.95

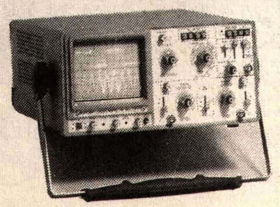
- * 4 independent channels, 8 traces
- * Time /Voltage cursor measurement
- * ALT triggering function for 4 ch.
- * Sweeps to 2ns/div, Delayed Sweep
- * TV Sync., Ch. 1 output, Z-axis input
- * 2 probes(x1, x10)

100 MHz Scope, 4ch. 8 traces
Best value all purpose scope
OS-6100B $1,329.95



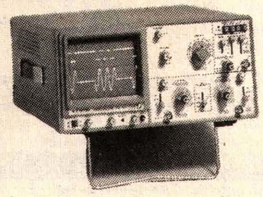
- * 4 channels, 8 traces
- * High sensitivity 500µV/div
- * Sweeps to 2ns/div, Delayed sweep
- * 20 kV accelerating voltage
- * TV sync., Z-axis input
- * A and B gate output
- * Best price 100 MHz scope
- * 2 probes(x1, x10)

50 MHz Triggering Oscilloscope
OS-653 $699.95



- * Dual Channel
- * Hold Off Function
- * Delayed Sweep
- * Built-in Delay Line
- * TV Sync
- * ALT Triggering
- * High sensitivity 1 mV/div
- * Trigger level lock function
- * Z-axis input, CH1 output
- * 2 probes(x1, x10)

20 MHz Oscilloscope
OS-622B $344.95



- * Dual trace, X-Y operation
- * TV Sync., Z-axis input,CH 1 output
- * High sensitivity 1 mV/div
- * Trigger level lock
- * 2 probes (x1, x10)

OS-645B - 40 MHz Cursor readout	$ 734.95
OS-625B - 20 MHz Cursor readout	$ 549.95
OS-623B - 20 MHz w/Delayed Sweep	$ 449.95
OS-935 - 5 MHz One channel	$ 209.95

DC Linear Power Supplies
Single Output

- * Constant voltage and constant current mode
- * Voltage regulation ≤0.01%
- * Current regulation ≤0.2%
- * Low ripple and noise
- * Overload and reverse polarity protection
- * Features 2 analog or 1 digital meter(PS series)
  2 analog or 2 digital meters(PR series)

PS-1830	(0-18V, 0-3A)	$209.95
PS-1830D	Digital Display	$219.95
PS-1850	(0-18V, 0-5A)	$219.95
PS-1850D	Digital Display	$244.95
PS-3030	(0-30V, 0-3A)	$224.95
PS-3030D	Digital display	$254.95
PS-6010	(0-60V, 0-1A)	$209.95
PR-1810H	(0-18V, 0-10A)	$349.95
PR-3060	(0-30V, 0-6A)	$314.95
PR-6030	(0-60V, 0-3A)	$299.95
PR-6030D	Digital Display	$399.95

Triple Output DC Power Supplies

- * Two variable 0-30VDC, 0-3A outputs
- * One fixed 5VDC, 3A output
- * Auto tracking
- * Auto serial and parallel operation
- * Constant voltage and constant current mode
- * Continuous/dynamic load can be selected
- * Features 4 analog or 2 digital displays

PC-3030	(0-30V, 0-3Ax2)	$499.95
PC-3030D	Digital display	$549.95

Programmable DC Power Supplies

- * High stability , low drift, 4 digit display
- * Front/rear output-sense switch selectable
- * Auto step running w/timer settings
- * 100 point programmability (PPS series)
- * 50 point programmability (PPT series)
- * Auto serial and parallel operation (PPT series)
- * Auto tracking (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G	(0-18V, 0-6A)	$1099.95
PPS-3635G	(0-36V. 0-3.5A)	$1099.95
PPS-6020G	(0-60V, 0-2A)	$1099.95
PPT-1830G	(0-18V, 0-3Ax2, 0-6V, 0-5A)	$1399.95
PPT-3615G	(0-36V, 0-1.5Ax2, 0-6V, 0-3A)	$1399.95

Digital Display Function Generator
FG-8016G $239.95

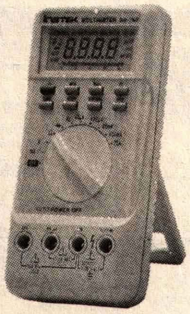
- * Frequency Range: 0.02Hz to 2MHz
- * Three Instruments in one: Function generator, Pulse generator & Frequency counter.
- * Sine, Triangle, Square, TTL Pulse and CMOS output
- * Built-in 6 digit counter with INT/EXT function
- * 1000:1 tuning range
- * Variable DC offset control

FG-8015 Function Generator	
* 0.02Hz-2MHz (No Counter)	$189.95
FC-8131 Intelligent Counter 1.3GHz	$469.95
FC-8270 Intelligent Counter 2.7GHz	$629.95
UC-2010G Universal Counter	$294.95

Digital Multimeter & C Meter
DM-8034(3½ digits) $179.95

- * 8 Function, AC/DC voltage, AC/DC current, resistance
- * Built-in C meter, diode test and audible continuity check
- * High voltage 1000V and 20A range
- * 0.5% basic accuracy

DM-8040 (3¾ Digits, True RMS)	
* Measures ACV to 50 kHz	$339.95
DM-8055 (5½ Digits)	$649.95
* 0.006% basic accuracy * 1µV, 1mΩ, 1nA resolution * dBm measurement * Auto range, relative mode, Max/Min	
DM-8055G(5½ Digits, GPIB)	$889.95



Model DM-392
(3¾ digits) $109.95

- * Auto/Manual ranging(38 ranges)
- * 42 Segment analog bar graph
- * Data Hold/Min-Max memory /Relative mode
- * Auto power off
- * Overload protection
- * Audible continuity check /diode test
- * Capacitance: 1pF-40µF
- * Frequency: 0.1Hz-1MHz
- * 20 Amp range
- * Double high energy fused (1A, 20A)
- * 0.3% DCV accuracy
- * **AC True RMS** (DM-394 only)

DM-351	3½ Digits w/Continuity, Auto Off	$54.95
DM-352	3½ Digits, Cap. Freq. hFE, 20 Amp	$79.95
DM-353	3½ Digits, Cap. Freq. Temp. hFE	$84.95
DM-391	3¾ Digits, Auto, Cap. Freq. Min/Max	$99.95
DM-392	3¾ Digits, Hold, Min/Max 20Amp	$109.95
DM-393	3¾ Digits, Peak, Logic, hFE, Freq	$119.95
DM-394	3¾ Digits, TRMS, Same as DM 392	$129.95

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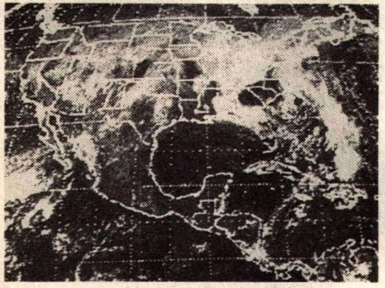
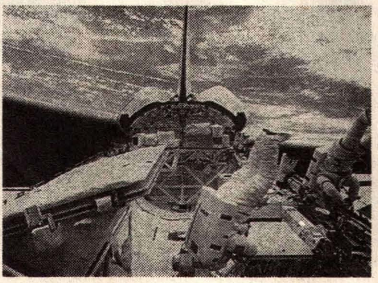


PC HF Facsimile $99

PC HF Facsimile is a simple, yet comprehensive short-wave fax system for the IBM PC and compatibles. It includes an FSK demodulator, advanced signal processing software, tutorial audio cassette, and complete reference manual. Just plug the demodulator into a serial port, install the software and getting FAX is a snap.

PC SSTV $149.95



PC Slow Scan Television is a complete system for sending and receiving full color amateur SSTV. The package includes an SSTV FSK modem, SSTV software, image capture utilities and reference manual. All popular formats are supported including Robot, Scottie, Martin and AVT. The system requires a 286, 386 or faster PC with VGA or super VGA display.

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For a limited time we are offering both software packages with a single FSK modem for under $200. This combination offer will let you send and receive all the popular HF image transmission modes.

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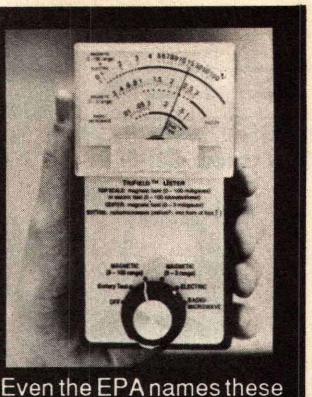

Most homes and offices have hot spots with strong artificial electro-magnetic fields, where chronic exposure may cause mental or physical problems. Even the EPA names these fields as suspected carcinogens. You can reduce your risk by avoiding these high-field areas.

The ***TriField***™ meter detects *far more* of these fields than any other electromagnetic pollution meter. It's the only one that independently reads AC electric fields, AC magnetic fields, *and* radio/microwaves. It also reads field strengths in *all directions simultaneously*. Every other meter that sells for under $500 reads only magnetic and only in one direction — they can entirely miss a magnetic field unless pointed correctly and are blind to radio/microwaves and electric fields, both of which cause biological effects.

The ***TriField***™ meter reads all three types of fields numerically and with a SAFE/BORDERLINE/HIGH SCALE, weighted proportional to effect on the body. Thresholds are based on epidemiological and laboratory studies. (While no *absolute* hazard thresholds have been established, reduction of *relative* exposure is prudent.)

The ***TriField***™ meter comes ready-to-use with battery, instructions, and one-year limited warranty. The cost is $144.50 postpaid.

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- Sensitive, picks up sounds at the level of a whisper.
- Up to 1 mile range.
- Requires 9V battery. (Not incl.)

SUPER-MINIATURE FM TRANSMITTER

Super small FM transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.

XST500 (E-Z) Kit $44.95

- Miniature photo battery mounts right on circuit board. (Included)
- Tunes 88-108 MHz.
- Up to 1/2 mile range.
- Sensitive 2 stage audio amplifier, picks up sounds at the level of a whisper..

MICRO-MINIATURE FM TRANSMITTER

Including the battery, this is the Worlds smallest FM transmitter. Use with any FM broadcast receiver. Easy to assemble, uses pre-assembled circuit board.

XWB1000 E-Z KIT $49.95

- Up to 1 mile range.
- Miniature photo battery mounts right on circuit board.
- Transmits at 143 MHz.
- Amazing audio sensitivity, picks up sounds at the level of a whisper.

CRYSTAL CONTROLLED FM TRANSMITTER

Including the battery, this is the Worlds smallest crystal controlled FM transmitter. Transmits to any scanner type receiver. Easy to assemble, uses pre-assembled circuit board.

XTL1000 E-Z KIT $69.95

- Smallest Phone transmitter anywhere!
- Tunes 88-108 MHz.
- No batteries required, powered by phone line.
- Up to 1/4 mile range.
- Attach to phone line anywhere in house, even inside phone.

SUPER-MINIATURE PHONE TRANSMITTER

Worlds smallest FM phone transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip components are pre-assembled to the circuit board.

XSP250 (E-Z) Kit $34.95

- Dial your phone from anywhere and listen to the sounds inside your home.
- Two digit Touch Tone code for secure operation.

TELEPHONE SNOOP

Call home from anywhere, enter a two digit security code, and hear the sounds in your home . Automatically turns on without ringing the phone, verifies code, then activates for one and a half minutes.

XPS-CASE KIT $13.95

XPS1000 (C) KIT ....

- Transmits a continuous beeping tone.
- Adjustable from 88 to 108 MHz.
- Up to 1 mile range.
- Works with any FM broadcast receiver.

TRACKING TRANSMITTER

Only 0.7 by 2.4 inches, the XTR100 operates at voltages of 3 to 18 Volts and is ideal for use in locating lost model rockets, bicycles, automobiles, games of hide and seek, and contests.

XTR100 (C) Kit $33.95

- Uses sensitive microwave transistor amplifier.
- Covers 1 to 2,000 MHz.
- Compact hand held unit.
- Includes miniature loud speaker for audio indication of detected signals.

SUPER SENSITIVE BUG DETECTOR

When the XBD200 intercepts a signal in the 1 to 2,000 MHz range, it emits a growl that increases to a high pitched squeal as the signal strength increases.

XBD200 (C) Kit $49.95

- Use with any FM broadcast receiver.
- Hear every sound in an entire house!
- Up to 1 mile range
- Powerful 2 stage audio amplifier.

MINIATURE FM TRANSMITTER

The XFM100 has a super sensitive microphone and is capable of picking up sounds at the level of a whisper and transmitting them to any FM broadcast receiver.

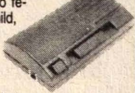
XFM100 (C) Kit $32.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Maintain anonymity on any call.
- Button for normal operation.
- 16 levels of voice masking.

VOICE CHANGING TELEPHONE

STOP THOSE ANNOYING TELEPHONE CALLS! Sound older and tougher when you want to. Not a kit. Fully assembled. Single phone operation only.

TRANSITION 2000 .... $89.95



- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Use with any modular phone.
- 16 levels of voice masking.
- Connects between handset and phone.

VOICE CHANGING ACCESSORY

STOP THOSE ANNOYING TELEPHONE CALLS! Sound older and tougher when you want to. Not a kit. Fully assembled. Use with single or multi-line phones.

TRANSITION 2001 .... $59.95

- **Uninterrupted** 800 to 950 MHz coverage.
- Works with any scanner that can receive 400 to 550 MHz.

800-950 MHz SCANNER CONVERTER KIT

If your scanner can receive 400-550 MHz, just add the XLC900 for **uninterrupted** 800-950 MHz coverage. It converts all 800-950 MHz signals to 400-550 MHz so your scanner can receive them! Add our custom case kit for that "Professional" look.

XLC-CASE KIT $13.95

XLC900 (C) KIT $49.95

- Transmit high quality stereo to any FM stereo receiver.
- Built-in output level monitor for quick and easy tuning.
- Ideal for use with personal CD player.

FM STEREO TRANSMITTER

Transmit full-bodied Hi Fi stereo to any FM stereo receiver. Separate left and right inputs and gain controls. Includes an output booster stage for greater range.

XFS-CASE KIT $13.95

XFS108 (C) KIT $41.95

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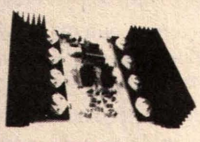
AF-2 ▲▲ 120-250W MOSFET POWER MONO AMPLIFIER (6 lbs.)

Kit:$ 89.80 Asmb$ 114.80

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). Frequency Response: 3-22,000HZ. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47K. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. Suggested Mark V model 012 transformer. Capacitor: 10,000uf 80V model 016. Suggested Metal Cabinet LG-1925.

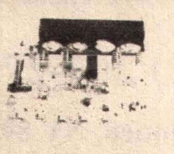
AF-3 ▲▲▲ 300W MOSFET HIGH POWER MONO AMPLIFIER (7 lbs.)



Kit: $ 165.00
Asmb.$ 195.00

Power Output: 300W into 4 ohms RMS. 200W into 8 ohms RMS. Frequency response: 10HZ-20KHZ.THD: < 0.03%. Signal to noise ratio:91dB. Input Sensitivity & Impedance at 1KHZ, 1V 47K. Load Impedance:4-16 ohms. Power Requirement: ±55 to ±65VDC 8A.Suggested Mark V model 009 Transformer. Capacitor 10,000uf 80V model 016. Recommended Metal Cabinet LG-1925.

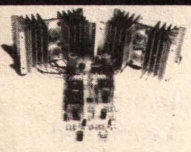
TA-800MK2 ▲▲ 120+120W PRE & MAIN STEREO AMP. (4 lbs.)



Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

TA-1000A ▲▲ 100W DYNAMIC CLASS A MONO AMP. (4 lbs.)

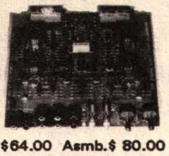


Kit:$ 54.00 Asmb.$ 74.00

Power Output: 100W into 8 ohms RMS, 125W into 4 ohms RMS. Frequency Response: 10HZ-100KHZ. THD: <0.008%. Signal to Noise Ratio:80dB. Sensitivity: 1V. Power Requirements: 35 to 45VDC @ 3A. Suggested Mark V model 001 or 008 transformer. Capacitor 10,000uf 80V model 016. Recommended Metal Cabinet LG-1924.

TA-388 ▲▲▲ CLASS A FET DYNAMIC BUFFER STEREO PRE-AMP. (1 lb.)

New



Kit:$64.00 Asmb.$ 80.00

Frequency Response (at rated output): Overall 10HZ-100KHZ +0.5dB-1dB. THD: Overall <0.007% at or below rated output level. Channel Separation (at rated output 1KHZ): Overall better than 70dB. Hum & Noise: Overall better than 90dB. Input Sensitivity (1KHZ for rated output): 300-600mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 500mA.

SM-100 ▲▲▲ 150 MHZ 8 DIGIT FREQUENCY COUNTER (2 lbs.)

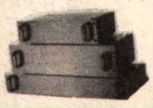
New Release

Kit:$ 79.00 Asmb.$ 99.00

Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KHZ range 10HZ-10MHZ 20mV(min.). MHZ range 1MHZ-120MHZ 20mV(min.), 120MHZ-150MHZ 35mV (min.), 150MHZ-200MHZ 40mV(typical). Time Base: 10MHZ crystal, ±10 ppm. Input Impedance: 1M ohm. Response Time: 0.2s. Resolution: 0.1 HZ: 10s gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time, 100 HZ: 0.01s gate time. Hold the last input signal. Reset counter to 0. DC 9V power adapter or 1.5VX4"D"size batteries.(Adapter not included)

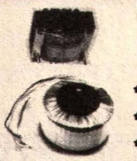
METAL CABINETS WITH ALUMINIUM FRONT PANEL (4-10 lbs.)

Best Buy



LG-1273	3x12x7"	$ 26.50
LG-1684	4x16x8"	32.50
LG-1924	4x19x11½"	38.25
LG-1925	5x19x11½"	42.00
LG-1983	2¼x19x8"	35.25

POWER TRANSFORMERS &**TOROIDAL TRANSFORMERS (5-12 lbs.)



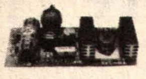
001	28/30V x 2	6A	$ 30.00
002	36V x 2	3A	25.00
003	40V x 2	6A	32.00
**008	28/30V x 2	6A	40.00
**009	48/53V x 2	8A	66.00
**012	33/40/42Vx2	6A	48.00

TY-2 ▲ FLUORESCENT LIGHT DRIVER

Kit:$ 14.75
Asmb.$ 20.50

This unit drives 6-40W fluorescent light for portable and emergency use. Works from a 7.2-16V DC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights. (1 lb.)

TR-503 ▲ REGULATED DC POWER SUPPLY



Kit:$ 18.75 Asmb.$ 27.65

It is short circuit proof and has overload protection. Output voltage is variable over a range of 0-50V. Current limit trip is adjustable up to max of 3A. Suggested Mark V 002 transformer. (1 lb.)

SM-302 ▲▲ 60+60W STEREO POWER AMP.

Kit:$ 75.00
Asmb.$ 94.00

It provides 3 input jack pairs. One pair accept a high impedance microphone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20HZ-20KHZ. THD:<0.1%. Input Sensitivity: Mic/Guitar 10mV,Hi 380mV,Lo 640mV. Ready to plug in when assembled. (11 lbs.)

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SM-666	Dynamic Noise Reduction	▲	$ 26.00
TA-006	6W Mini-Amplifier	▲	9.50
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TA-120	36W Class A Power Amp.	▲▲	32.50
TA-201	Mircophone Mixer Mono Amp.	▲	20.79
TY-45	20 Bar/Dot Level Display	▲▲	41.45
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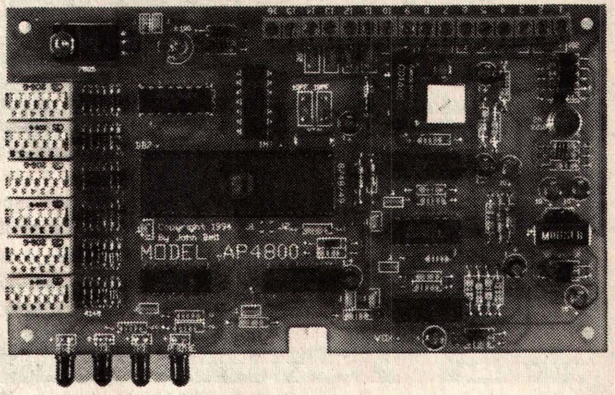

DTMF Controlled Autopatch and 4 control outputs. Switch selectable CWID. VOX or COR receiver control. Assembled tested board. LED's for Power, TX, RX, Phone. Intel 8748 microcontroller. Board size 3.8 x 6.3 inches. You add receiver, transmitter, power supply (12v), phone line, and antenna system. Circuit board is top quality, double sided, plated through holes, solder mask on both sides and parts legend. Shipping $4 for UPS GROUND or $6 for UPS BLUE, COD add $4. For more information call or write to:

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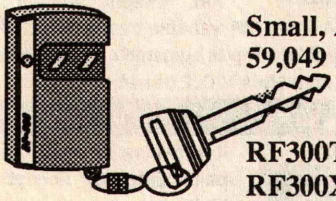
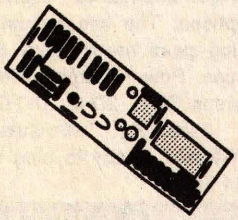
Miniature Transmitters and Receivers



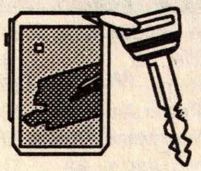
Small, Attractive, High End Quality, 2 Channel 318 MHz Transmitter
59,049 Settable Codes, 120'–300' Range, 1-1/4" x 2" x 9/16", Assembled

	Qty	1	5	10
RF300T	150' Range Transmitter	24.95	19.95	15.95
RF300XT	300' Range Transmitter	29.95	24.95	19.95



Small, High End Quality, 2 Channel Receiver for the RF300 Transmitters
1-1/4" x 3-3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

	Qty	1	5	10
RF300R	Receiver, Fully Assembled	24.95	20.95	16.95
RF300RK	Receiver, Complete Parts Kit	19.95	15.95	12.95
RF300PA	Pre-Amplifier. Doubles Range	14.95	11.95	9.95



Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1-7/8"x2-3/8"x7/16" (T), 2"x2-3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

	Qty	1	5	10
RF60	Transmitter and Receiver Set	24.95	19.95	14.95

Add $ 4 shipping for first item + $ 1 for each additional item. Ca. residents add 8.25% tax
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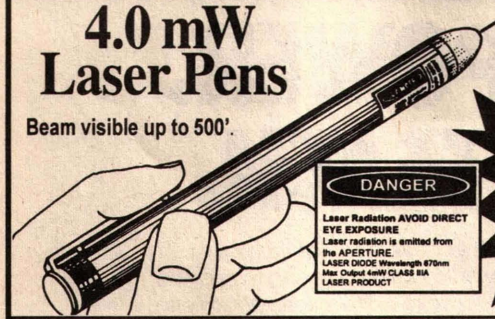
4.0 mW Laser Pens

Beam visible up to 500'.



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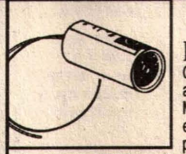
LASER DIODE Wavelength 670nm
Max Output 4mW CLASS IIIA
LASER PRODUCT

INCLUDES
2 AAA Batteries
Pen Size: 5 1/2" x 1/2"

SUPER NEW LOW PRICE
$59.95

4.0 mW Laser Diode

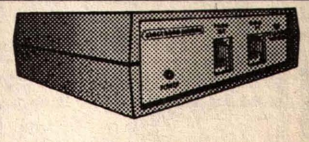


Great for making a gun sight. Makes a super experimenters project. A beam wavelength of 670 nm. Size of beam is 6mm at 5 meters. Operates on 3 volts DC at 85mA. Size: 10.5mm x 18.5mm.

LDM-5

NEW LOW PRICE $59.95

The Exciting New TELEPHONE MONITOR



Monitors your phone system, See how accurate your phone company really is!

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- Date & time of each call.
- Length of the call.
- What number was dialed.
- If you use a credit card it records the card number.

2. RECORDS INCOMING CALLS :
- Date & time of call.
- How many times phone rings.
- If answered the length of call.

3. RECORDS ANY DTMF TONE :
- Detects any tone on line sent by phone company or any other source.

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- Connects to parallel port
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- Phone line out to telephone.

All software included!

TM-1 ONLY **$99.95** KIT

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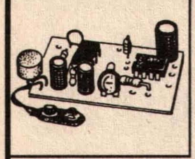
SUPER SNOOPER BIG EAR



Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. SIZE: 1"x.75" 6 to 12vDC

AA-1 **$10.95** **BUILT $29.95**

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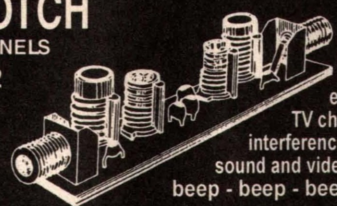
FOR CHANNELS
2 thru 22

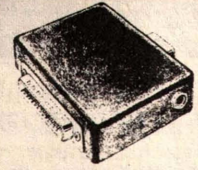


Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep - beep - beep.

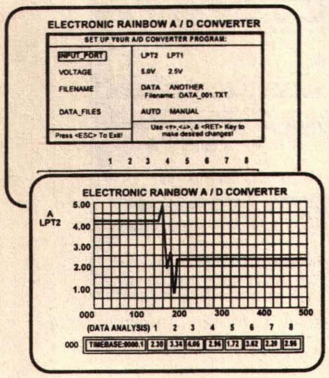
NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222 Kit **$14.95**

8 CHANNEL AtoD CONVERTER KIT



Complete with Software. Over 20 DOS programs provided!



ELECTRONIC RAINBOW A / D CONVERTER

SET UP YOUR A/D CONVERTER PROGRAM:

INPUT_PORT	LPT2 LPT1
VOLTAGE	5.0V 2.5V
FILENAME	DATA ANOTHER Filename: DATA_001.TXT
DATA_FILES	AUTO MANUAL
Press <ESC> To Exit!	Use <↑>,<↓>, & <RET> Key to make desired changes!

1 2 3 4 5 6 7 8

ELECTRONIC RAINBOW A / D CONVERTER

000 TIMEBASE:0000.1 2.30 3.34 4.06 2.96 1.72 3.82 2.20 2.96

- Connect your computer to the outside world through a parallel port!
- Monitor eight sperate 8 bit analog inputs simultaneously and display them digitally or graphically.
- Use your computer as an oscilloscope using the provided DOS software!
- Hardware selectable 0-2.5 VDC or 0-5 VDC input range. Chart provided to calculate scaling resistors (resistors not included).

SIZE: 3"x2.5"x1" case. Mates to parallel port on back of PC.

AD-8 KIT **$89.95**
BUILT $109.95

16 DIGIT DTMF DECODER

Control anything by telephone from around the world!

Enter a code (Code can be any number up to 16 digits) **and control....**
- Turn lights on while on vacation.
- Start your furnace or air before you go home.
- Switch your incoming line to a fax.
- Make your phone so it will not call to a long distance or a 900 number.
- Connect this unit to the AA-1 kit and listen to anything in the room.

Requires an answering machine to function.

DTMF-1 KIT **$74.95**
BUILT $99.95

WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-1 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. SIZE: .8"x1" 6 to 12vDC

WM-2 **$14.95**

RAINBOW KITS
SCHEMATICS
PARTS LAYOUT
P.C. BOARD LAYOUT
ELECTRONIC RAINBOW

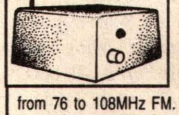
This Manual contains schematics, parts lists , P.C.B., layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

KIT BOOK

$14.95

$9.95 with the purchase of any kit.

FM STEREO TRANSMITTER



Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your cd's while mowing the lawn,Play music on one channel sing on the other. Clarity is excellent, aprox. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls , & crystal for stereo separation. 9v battery operation

FMST-100 **$29.95** / FMSTC cabinet **$8.95**

*Please add sufficient postage First lb **$5.00** Canada **$7.00***
*Additional LB. Add **$1.00** US FUNDS ONLY*
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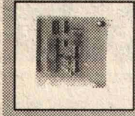
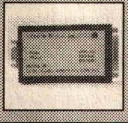
MODEL 30 .... $79



- PLUGS INTO PC BUS
- 24 LINES DIGITAL I/O
- 8 CHANNEL-8 BIT A/D/ IN
- 12 BIT COUNTER
- UP TO 14K SMP/SEC

MODEL 45 .... $189

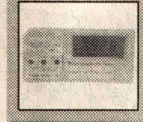


- RS-232 INTERFACE
- 8 DIGITAL I/O
- 8 ANALOG INPUTS
- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT

MODEL 100 .... $279

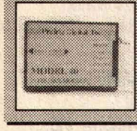
- 12 BIT 100 KHZ A/D
- 4 ANALOG OUTPUTS
- 3 TIMER COUNTERS
- 24 DIGITAL I/O

MODEL 150-02 .... $179



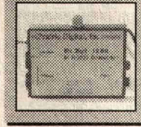
- RS-232 INTERFACE
- TRMS, 20 AMPS
- 12 BIT A/D
- OPTO-ISOLATED
- COMPLETE DMM

MODEL 40 .... $99



- RS-232 INTERFACE
- 28 LINES DIGITAL I/O
- 8 ANALOG INPUTS
- PWM OUTPUT

MODEL 70 .... $239



- RS-232 INTERFACE
- 18 BIT A/D
- 5.5 DIGIT
- UP TO 60 SMP/SEC

Prairie Digital, Inc.

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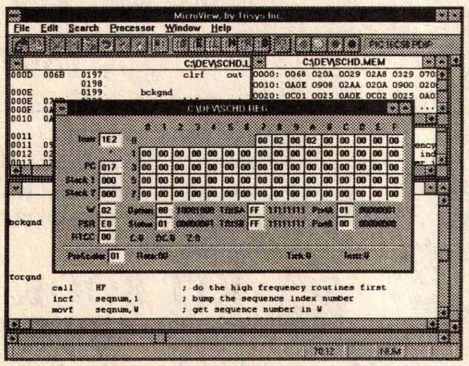
MicroView™ Simulation Environment



MicroView, by Trisys Inc.
File Edit Search Processor Window Help
C:\DEV\SCHD.L
C:\DEV\SCHD.MEM
C:\DEV\SCHD.REG

```
000D   006B    0197              clrf     out
               0198
000E           0199      bckgnd
```

```
0000: 0068 020A 0029 02A8 0329 070
0010: 0A0E 0908 02AA 020A 0900 020
0020: 0C01 0025 0A0E 0C02 0025 0A0
```

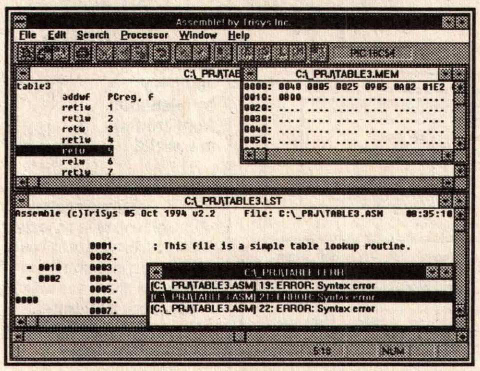
```
forgnd
      call    HF            ; do the high frequency routines first
      incf    seqnum,1      ; bump the sequence index number
      movf    seqnum,W      ; get sequence number in W
```

MicroView is a full-featured simulation environment for the Microchip PIC 16C5X microcontrollers. Other simulation engines available.

- Integrated Programming Editor, Macro-Assembler
- Bookmarks, Search and Replace, UnDo
- Error Report, Listings, Context Sensitive On-line Help
- Single Step, Register Edit, Run to Line
- Full Breakpoint Capability

$149.⁹⁵USD

Assemble!™ Universal PIC Assembler



```
table3
        addwf    PCreg, f
        retlw    1
        retlw    2
        retw     3
        retlw    4
        relw     5
        relw     6
        retlw    7
```

```
0000: 0040 0005 0025 0905 0A02 01E2
0010: 0800 .... .... .... .... ....
0020: .... .... .... .... .... ....
0030: .... .... .... .... .... ....
0040: .... .... .... .... .... ....
0050: .... .... .... .... .... ....
```

```
Assemble (c)TriSys 05 Oct 1994 v2.2     File: C:\_PRJ\TABLE3.ASM    08:35:10

               0001.     ; This file is a simple table lookup routine.
               0002.
  - 0010       0003.
  - 0002       0004.
               0005.
0000           0006.
               0007.
```

```
[C:\_PRJ\TABLE3.ASM] 19: ERROR: Syntax error
[C:\_PRJ\TABLE3.ASM] 21: ERROR: Syntax error
[C:\_PRJ\TABLE3.ASM] 22: ERROR: Syntax error
```

Assemble! is a universal macro-assembler for the complete line of Microchip PIC microcontrollers. Compatible with PICMASTER and the Parallax downloader.

- Integrated Programming Editor, Macro-Assembler
- Bookmarks, Search and Replace, UnDo
- Error Report, Listings, Context Sensitive On-line Help
- COD File Format, INHX8S, INHX8M, INHX16
- Memory Window, Direct Download to **PICSTART**

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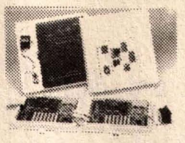
EDS-8811 $289.00 E(E)PROM programmer for BGC- 8088 or IBM PC/compatible. Burn your own EPROM in just a few minites.

BGC-8052 $979.00 It helps you learn the most powerful and popular Intel 8051/8052 Embedded Microcontroller in today's appliance control. Learning guide and experiment examples included.

U-DBGR $1599.00 Universal Debugger/In-circuit Emulator for commonly used Microprocessors, such as 6502, Z80, MCS-48, MCS-51, 8088, .. etc.. Trace & debug program, EPROM programmer, DOS Shell. Can be operated with BGC-8088 or IBM PC/compatible. Speed up your development.

APEX-IE 8052 $699.00 In-Circuit Emulation Systems for 8051/8052. It helps you understand microprocessor based control circuit design, troubleshooting, assembly language programming and debugging. Can be operated on BGC-8088 or IBM PC/compatible. Speed up your product design.



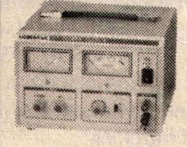
CIC-100 $549.00 IBM PC/compatible I/O control applications, learn Assembly, C, and BASIC programming languages, 800-pin solderless breadboard for circuit design andtest, I/O drivers for controlling relay, step motor, LED, speaker, sensor, ..etc.. Experiment manual. Application control modules available, including step motor, matrix keypad, traffic light, A/D, D/A, F/V, V/F converters, sensors, etc.

EDS-8809-1 $589.00 IBM PC/compatible(add an adapter $99.00) and BGC-8088 I/O control applications include 24 experiments, such as stepper motor control and simulation, digital clock, speaker control, dot matrix LED control , Matrix keyboard, sign lights, 8255 polling handshakes, electric piano, stop watch,.. more.

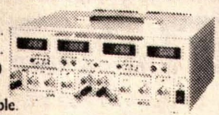
EDS-8804 $239.00 A/D and D/A converter applications for BGC-8088 or IBM PC/compatible.

EDS-8805 $479.00 Servo motor and stepper motor control for BGC-8088 or IBM PC/compatible.

DC POWER SUPPLY



PS-303 $159.00
0-30VDC, 0-3A; 0.02%+2mV line regulation; 0.02%+3mV load regulation; 1mVrms noise & ripple; Short circuit/overload protection; constant current/voltage(CC/CV).
PS-303D $314.95 dual outputs.
PS-305 $219.95, 0-30VDC, 0-5A.
PS-305D $399.95, dual.
8110 $289.95 0-60VDC, 0-3A.
8112 $399.95 0-60VDC, 0-5A.
8108(8109) $549.95($699.95) 0-60VDC, 0-3A(5A), dual, independent tracking. Low ripple.



8102(8103) $399.95($489.95) dual 0-30VDC/0-3A(5A), fixed 5VDC/3A, indepedent tracking operation, constant voltage and current. Slave/Master, Serial/Parallel connection.
PS-1610S(8107) $289.00($399.95) 0-16VDC, 0-10A.
PS-2243(2245) $139.00($159.00) 0-12/0-24VDC,3A(5A).
8200(8201) $179.95($239.95) 0-30VDC(digital meter), 0-3A(5A). **8210(8211) $199.95($259.95)** two digital meters.
8202(8203) $499.95($549.95) 3 outputs, digital display, dual 0-30VDC/0-3A(5A), a fixed 5VDC/3A, indepedent tracking operation, constant voltage and current.

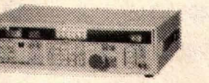
AM/FM SWEEMAR SCOPE

SM-6225B/C $1999.95
Freq Range: (AM)490KHz, (FM) 10-11.4MHz, *Acuracy*: ± 0.1%
Marker: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

STEREO SCOPE **OS-7505B $369.00** trigger, 0-10MHz.

ALIGMENT SCOPE **OS-7001A $369.00** 0-200KHz.

AM/FM STD SIGNAL GEN.



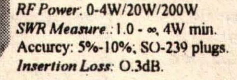
SG-4110A $1799.00
Freq: 100KHz-110MHz
Display: 6-digit LED
Accuracy: <±(5x10-E5 ±1 count)
Resolution:100Hz (100-34.99MHz); 1KHz (35MHz-110MHz).
Output: -19dBu, -99dBu, 1dB steps. *Impedence*: 50Ω VSWR 1.2.

TV COLOR PATTERN GEN.

CPG-1366A $159.95
VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedence: 75 Ohm;
Video Output: BNC, 1Vp-p

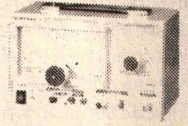
SWR/RF POWER METER

310 $89.95
Freq.Range: 1.8-150MHz.
RF Power: 0-4W/20W/200W
SWR Measure.: 1.0 - ∞, 4W min.
Accurcy: 5%-10%; SO-239 plugs.
Insertion Loss: O.3dB.
Input/Output Imp.: 50Ω.



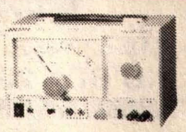
320 $89.95, 130-520MHz.
330 $119.95, 1.8-520MHz.
SWR-3P $26.95 1.7-150MHz; *RF Power*: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.
PM-330 $136.00 1.8-500MHz; 0-5W/20W/120W.

RF SIGNAL GENERATOR



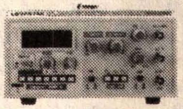
SG-4160B $119.00
100KHz-150MHz up to 450MHz on 3rd harmonics; 6 ranges; AM modulation. *RF Output*: 100mVrms to 3-5MHz. *Modulation*: Int. 1KHz AM, Ext. 50Hz-20KHz AM.
Audio Output: 1KHz, 1Vrms.
SG-4162AD $229.95, with Freq. Counter 1Hz-150MHz. 6 digits, for internal & external signals.

AUDIO GENERATOR



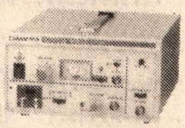
AG-2601A $119.00
10Hz-1MHz, 5 ranges;
Output Level: sinewave 0-8Vrms, square 10Vp-p.
Output Impedence: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz, <0.5% 50KHz-500KHz.
AG-2603AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals.

FUNCTION GENERATOR



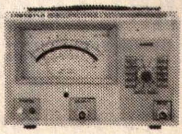
FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Triangle, Pulse & Ramp
Output: 5mVp-p-20Vp-p, 1% distortion.
VCF: 0-10V control freq. to 1000:1.
FG-2102AD $229.95 generates signals same as FG-2100; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
(FG)2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG.
Freq. Counter: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz

FM STEREO MODULATOR



AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Seperation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Seperation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz..

AC MILLIVOLT METER

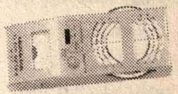


MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedence 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

OSCILLOSCOPE

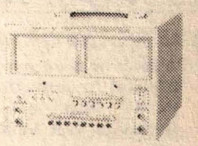
OS-7305B $249.00 DC~7MHz; *Vertical*: 10mV/Div; Horizontal: 250mV/Div, 10Hz~100KHz in 4 ranges; 3" CRT;Internal and External Sync.; Input: 1MΩ/35pF.
OS-7010A $369.00 DC~10MHz. 5" CRT, 10mV/Cm~10V/Cm, 1MΩ.
OS-622B $344.95 20MHz/dual trace
OS-653 $699.95 50MHz, dual, delay sweep, ALT trigger, TV syn.
OS-6100B $1329.95 100MHz, 4ch. 8 traces, delay sweep,best buy

GRID DIP METER



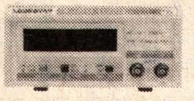
DM-4061 $89.95 1.5-250MHz, 6 bands;6 plug-in coils, 2 transistor, and 1 diode.
Modulation: ≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absortion meter. Using 9VDCpower supply.

AUTO DISTORTION METER



DM-3104A $799.95
MEASUREMENT:
Range: 0.01%-30%, 0.1/0.3/1/3/10/30% full scale
Freq.: 400Hz±10%, 1000Hz±10%(HPF).
Input: 3mV-100V, ratio measuring 20dB.
Auto. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
DM-3204 $1,599.00 dual channels.

FREQUENCY COUNTER



FC-5250C $119.95
Freq. Range: 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10MHz-200MHz
Gate Time: 0.1 & 1sec.
Max. Input: 10Vp-p.
Input Sensitivity: 35mV 10Hz-200MHz.
Input Imped.: (HF) 1MOhm, (VHF) 50Ohm.

FC-5260A $146.00 10Hz-600MHz.
FC-5270A $149.95 10Hz-1300MHz.
FC-5600B $321.00 10Hz-600MHz.
(FC)5700B $329.95 10Hz ~ 1.3GHz.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95
TRACER: Gain Max. 60dB
Attenuation: 0/20/40/60dB
Input Imped.: 100KOhm
Output Imped.: 600Ohm;
Speaker: 8 Ohm.
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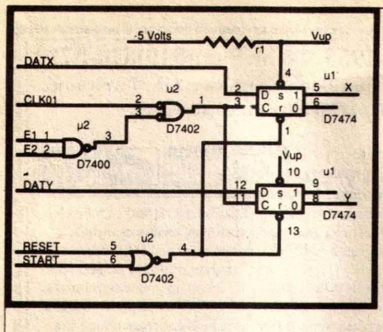

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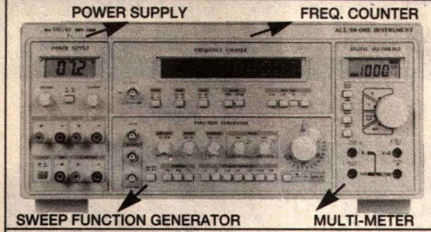

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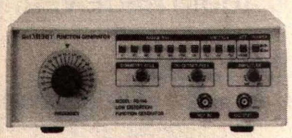

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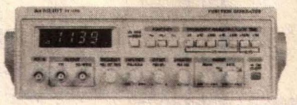

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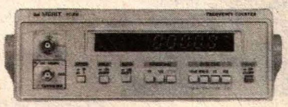

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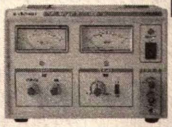

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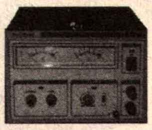

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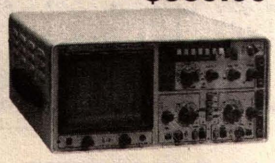

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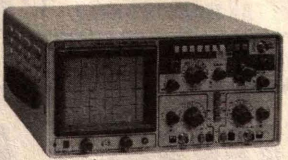

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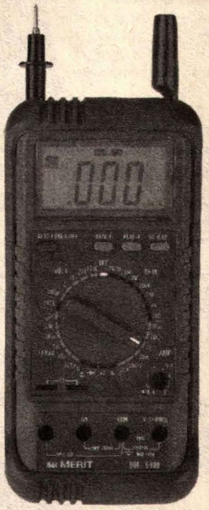

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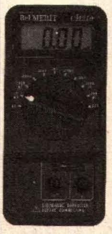

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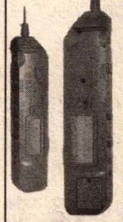

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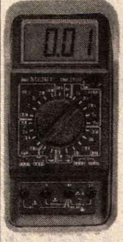

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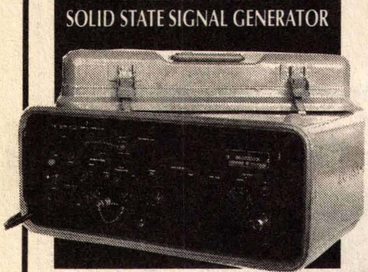

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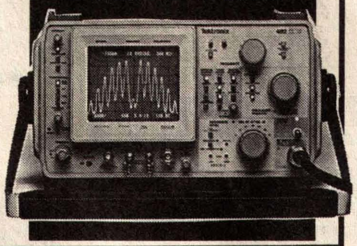

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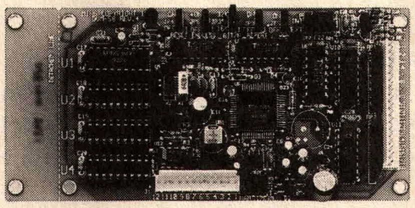

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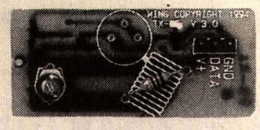

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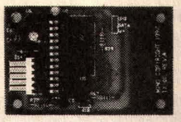

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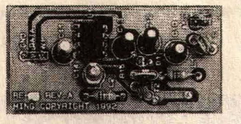

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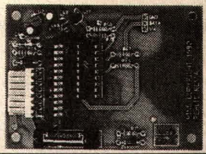

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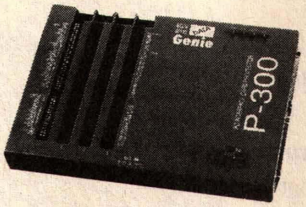

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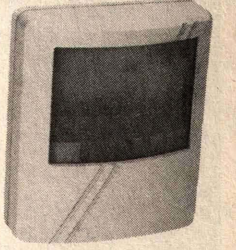

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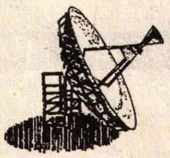

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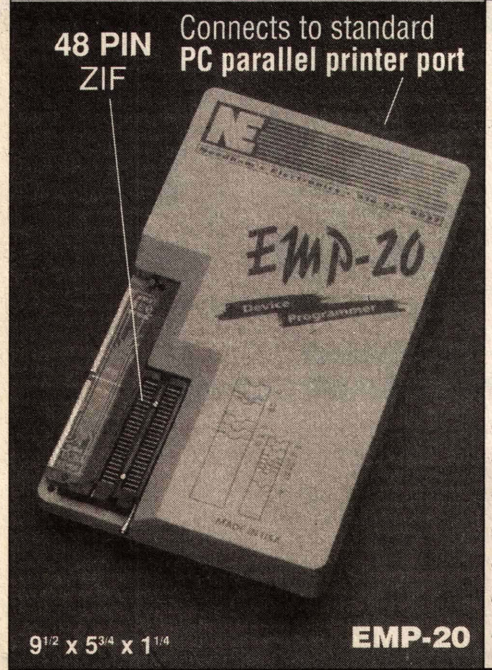

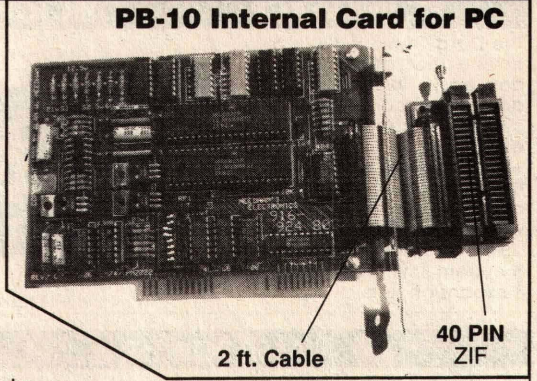

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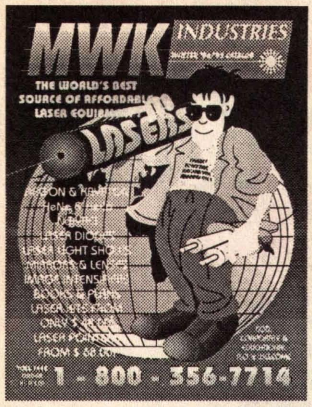

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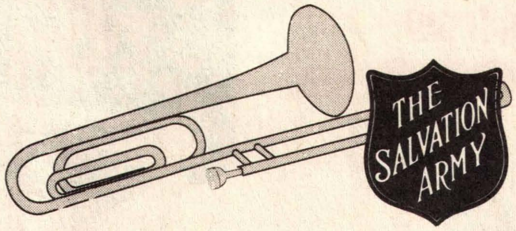

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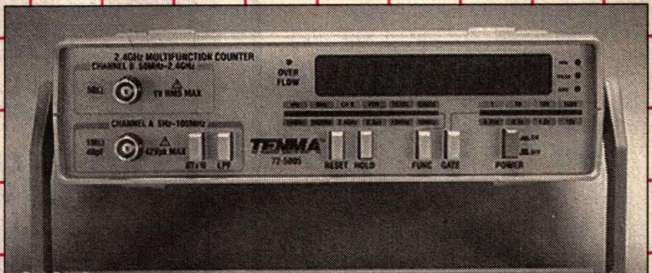

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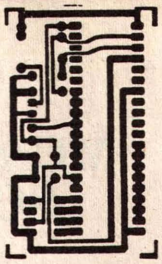

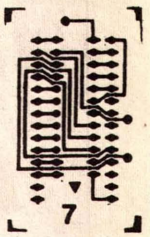

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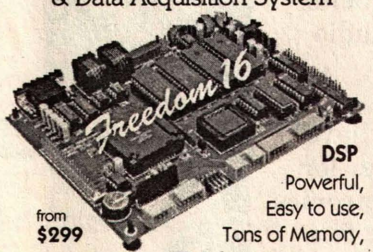

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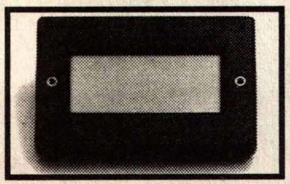

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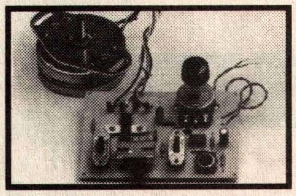

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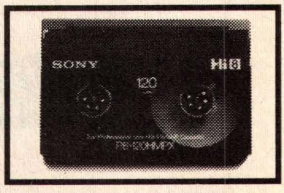

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74LS15	.40
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74LS22	.34
74LS26	.34
74LS27	.34
74LS28	.45
74LS30	.35
74LS31	.35
74LS32	.40
74LS33	.40
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74LS75	.40
74LS76	.65
74LS78	.65
74LS83	.59
74LS85	.59
74LS86	.55
74LS90	.55
74LS91	.69
74LS92	.65
74LS93	.49
74LS95	.59
74LS96	.75
74LS107	.45
74LS109	.48
74LS112	.45
74LS113	.99
74LS114	.45
74LS122	.57
74LS123	.59
74LS125	.45
74LS126	.45
74LS132	.55
74LS133	.59
74LS136	.49
74LS137	.75
74LS138	.49
74LS139	.49
74LS145	.69
74LS147	1.59
74LS148	.89
74LS151	.49
74LS153	.49
74LS154	1.49
74LS155	.59
74LS156	.59
74LS157	.59
74LS158	.40
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74LS367	.45
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74LS373	.75
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74LS375	.99
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78L15	.45
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7808T	.59
7810T	.59
7812T	.59
7815T	.59
7824T	.59
7805K	1.79
7812K	1.79
7815K	1.79
7824K	1.79
78M05	.59
78M08	.59
78M12	.59
78M15	.59
78M24	.59
UA78S40	2.39

Negative Output

79L05	.45
79L12	.50
79L15	.55
7905T	.59
7906T	.59
7908T	.59
7910T	.59
7912T	.59
7915T	.59
7924T	.59
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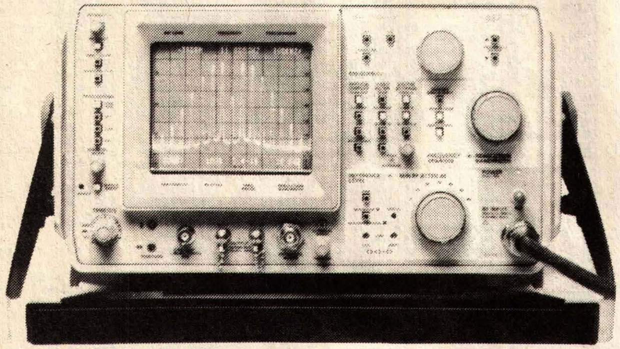
VISA

TEKTRONIX 492 SPECTRUM ANALYZER



Covers 50KHz - 21 GHz. Solid state portable unit features internal phase lock, minimum sensitivity is - 95 dBm. This unit includes OPTIONs 1,2,3. (1-RF Preselection),(2-Digital storage),(3-Freq stablization 100Hz Resol'n)

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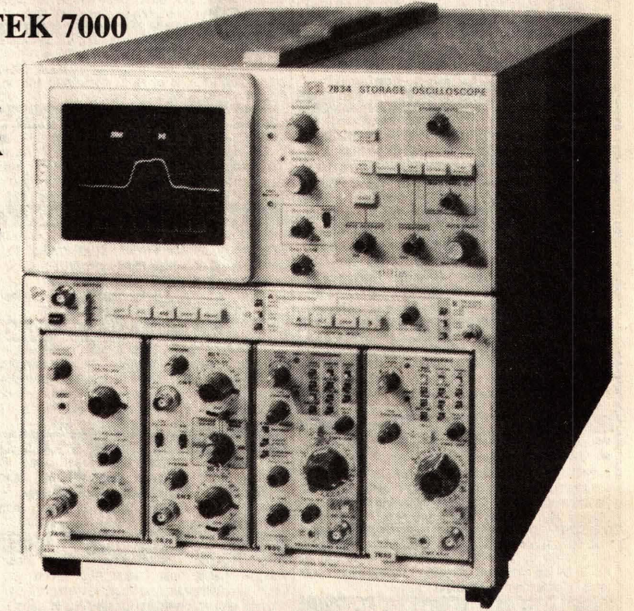

7834 STORAGE OSCILLOSCOPE

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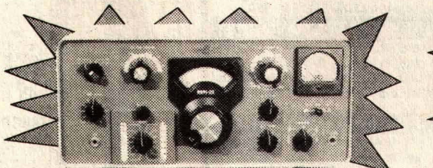

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Price: $595.00 with piggyback pwr-supply.
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Please include telephone/fax number with mail-in orders.
Orders must be prepaid by guaranteed instrument.

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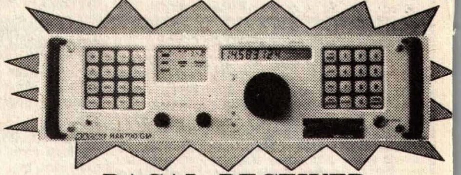

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Superior quality and design are standard in this 500Khz-30Mhz general coverage receiver. Modes of operation are AM,FM,CW,U/LSB,ISB -optional, with room for seven bandpass filters. The illuminated LCD display features large readable digits for frequency and mode status as well as AF or RF signal strength.Tuning can be directly entered via keypad or with a tuning knob. Three different gain modes are Manual, Automatic, and Automatic with selectable threshold. Fully Checked & Operational.

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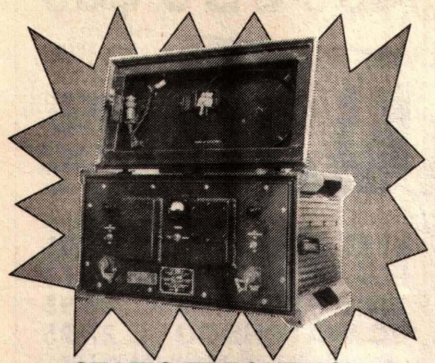
Bandpass Filters: 400Hz/1.2KHz/2Khz/6.8KHz 16Khz/USB/LSB are **$65.00** ea. max 4 per unit.

**** NOTE: if there are specific items you are looking for regardless of whether or not they appear in this ad, we would be happy to provide you with a quote including, availability, pricing information and shipping details.**

CIRCLE 326 ON FREE INFORMATION CARD



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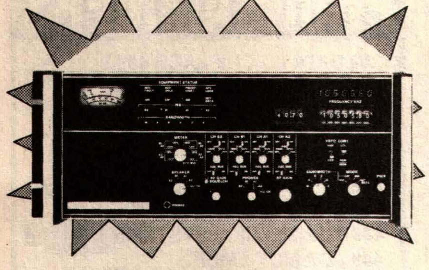
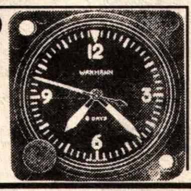
Dim=L21"xW12"xH15" Weight=99lbs



ROCKWELL / COLLINS HF8054A

Four channel HF receiver.

"Top of the Heap" certainly describes this commercial communications receiver. Produced by what most folks consider the best and most desirable manufacturer in North America. There's nothing like a Rockwell/Collins HF80 series receiver, and to "*top that*", OUR's are factory new in the orig. carton from the Toronto mfg. facility. These units are loaded with the following options. - 10Hz tuning resolution,-remote control, high stability tcxo,-four chan. audio output, and completed with 6 bandpass filters. The bonus? "no scratches". **Price: $3,700.00**

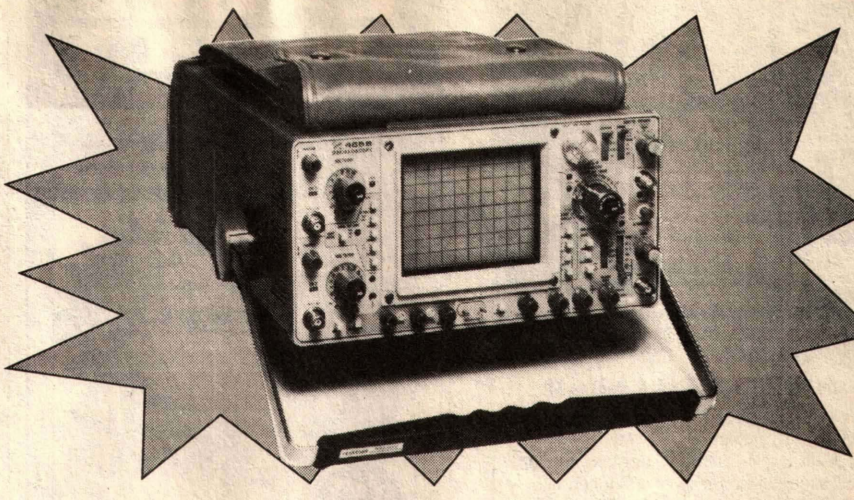


Just Arrived- $39.00

8-DAY AIRCRAFT CLOCK

1-7/8" dial

Great collectors item for the ham shack, fifties vintage funct/chkd.



TEKTRONIX 465B

Proof is in the pudding when it comes to this instrument's track record. There's no doubt, that popularity speaks many languages when speaking of the "465B". This excellent instrument continues the tradition of the standard 465 oscilloscope by adding useful features such as CH-1, CH-2 sum or difference, trigger view in any combination, alternate sweep and trace selection versatility. Many technicians dream of owning a quality 100-MHz oscilloscope, but funding rairly permits. Fortunately, we were recently able to aquire a limited supply of 465B-s in nearly *new* condition. Our LOW PRICES will likely permit "you" to own one of the best scopes anywhere in the country. If your needs are current and action *swift* you too will be a member of a growing club!!!

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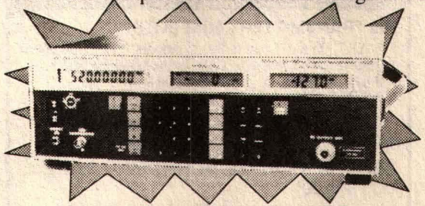
VERY GOOD CONDITION................$695.00

These instruments are fully checked out and calibrated. They are supplied with an original front panel cover and complete service manual. Original TEK Probes are $75.00 each with each purchase.



MARCONI SYNTHESIZED SIGNAL GENERATOR

Model 2018

Freq range 80Khz-520Mhz with calibrated output levels from -127 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB, reversepower protection of up to 50W is possible without damage to the instrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab. **Price : $1750.00 Checked**

PDR-63 PORTABLE RADIAC METER

This portable radiac set is loaded with all kinds of extras featuring six ranges of sensitivity for both Gamma or Beta radiation measurements. The 1st scale 0-1 rad/hr up to 0-5000 rad/hr. The unit comes supplied with headset & bat/charger. Req's only 4 AA Batteries. **Price: $149.95**

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-HP 8160A OPT-20 PROG PULSE GEN	$3,995.00
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-MARCONI MOD 2019 SYNTHESIZER 1024MHz	$2,800.00
-ROHDE & SCHWARZ SIG GENERATOR .4-484MHz	$ 500.00
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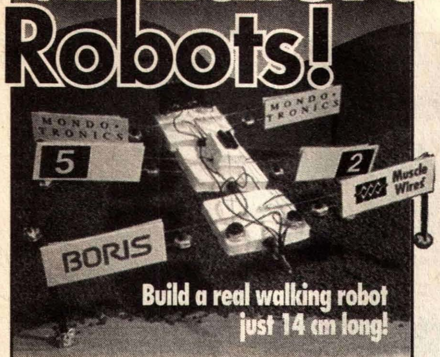

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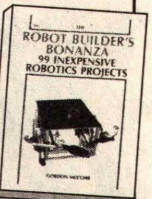

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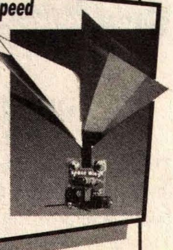

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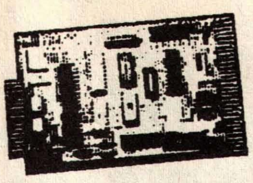

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99	SUNSHINE 4 GANG
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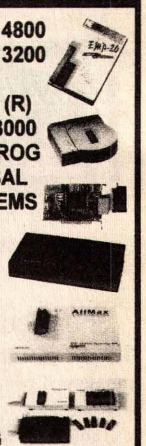

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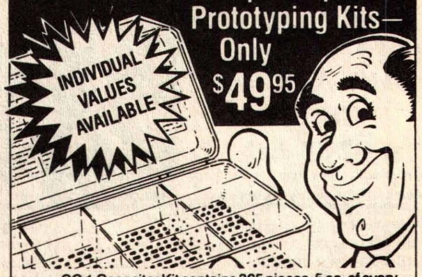

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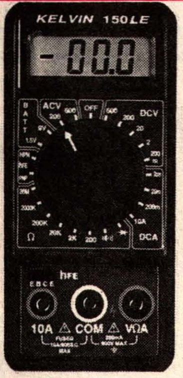

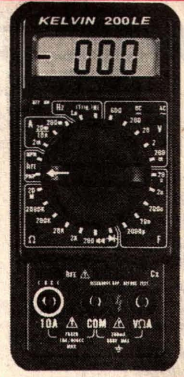

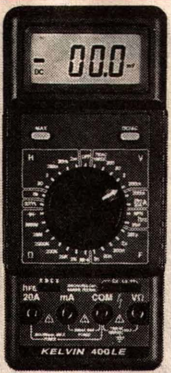

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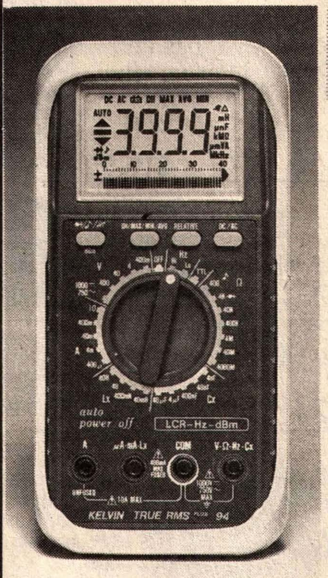

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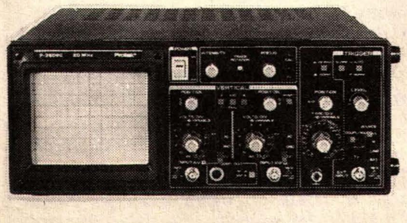

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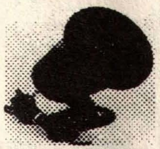

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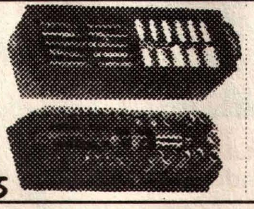

55 pieces. 5-way reversible ratchet. Screwdriver bits and sockets. Quality tools and the best prices.

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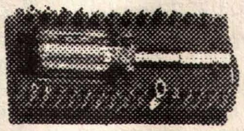

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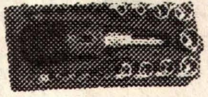

24 pieces. Stubby ratchet. Screwdriver bits and socket set.

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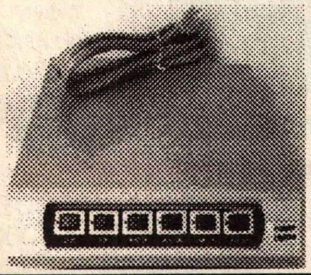

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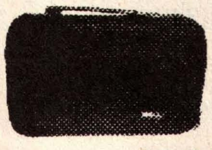

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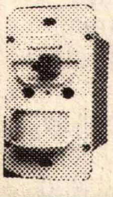

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Digital Panel Meter
PM-128 3-1/2 Digit LCD

FEATURES:

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- Single 9VDC operation
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- 13mm figure height (Approx. 1/2")
- Automatic Polarity indication
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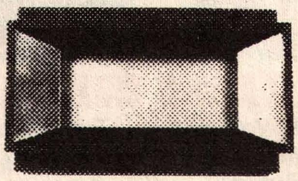

SIZE: 68mm X 44mm
2-5/8" X 1-13/16"

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KIT

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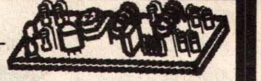

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RT 101 keyboard..................Brand new in the box..................**$15.95**

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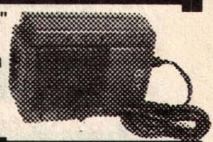

"GOOD THINGS COME IN SMALL PACKAGES"
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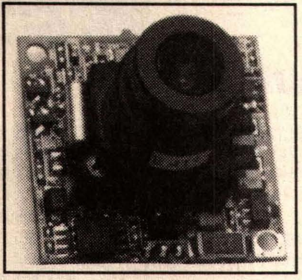

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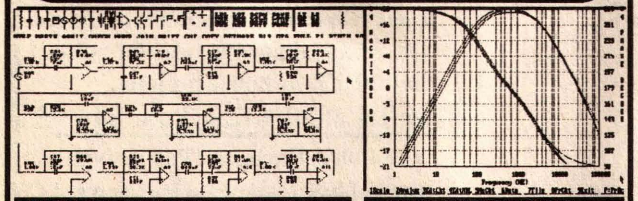

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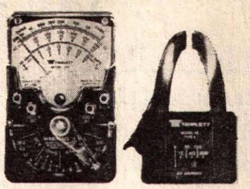

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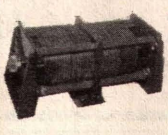

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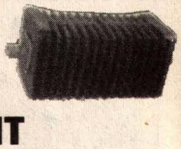

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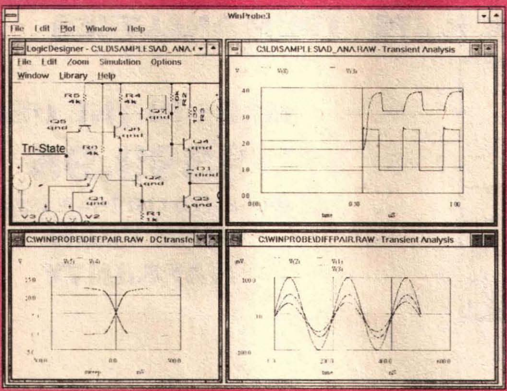
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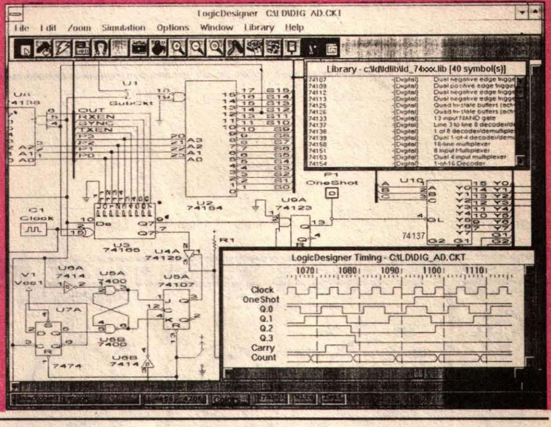
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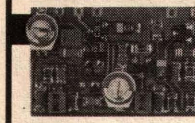

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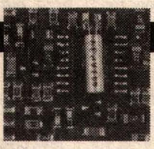

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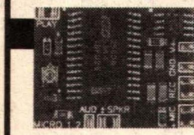

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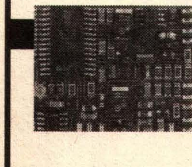

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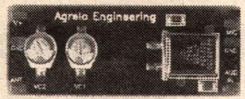

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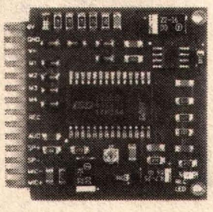

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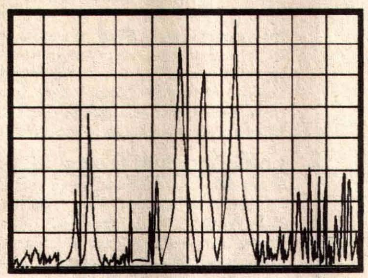

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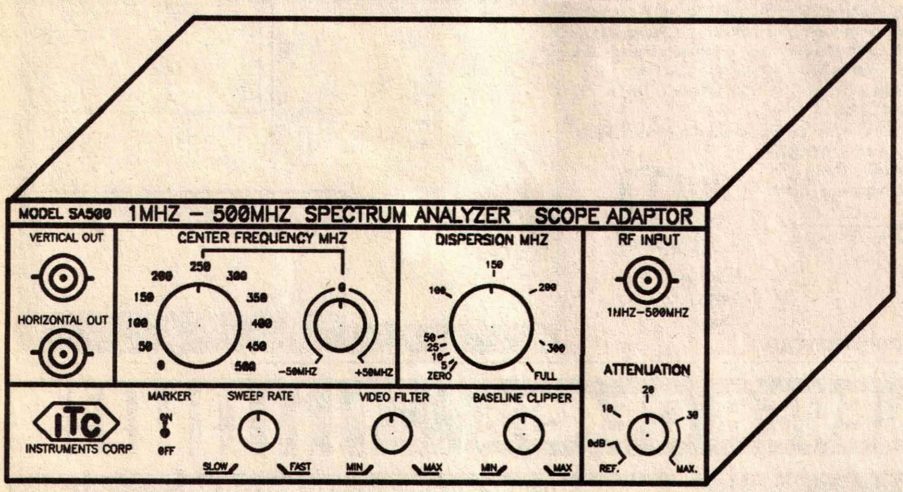
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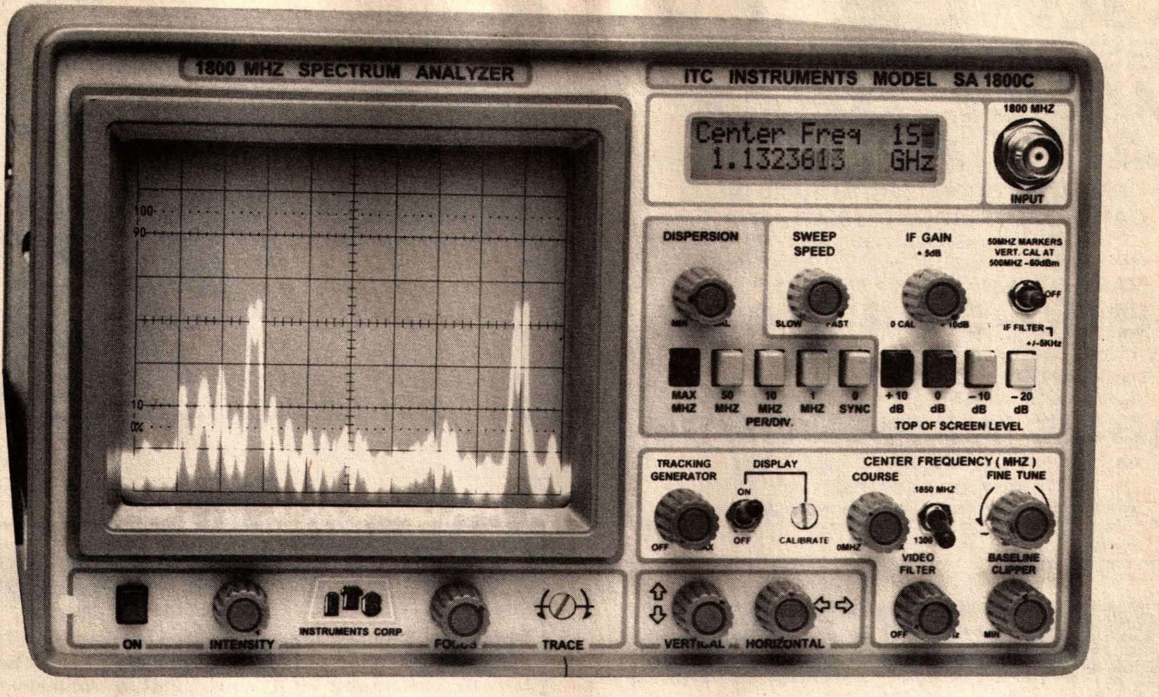
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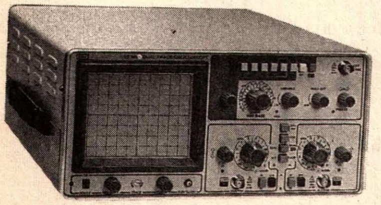

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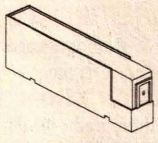

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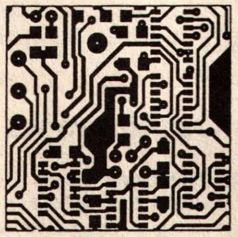

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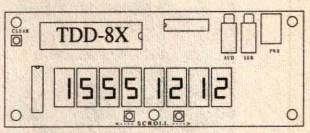

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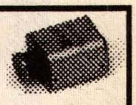

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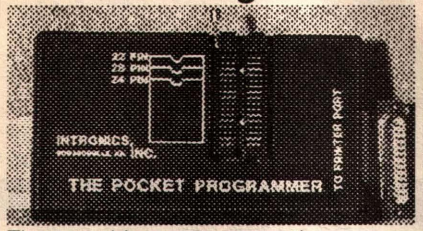

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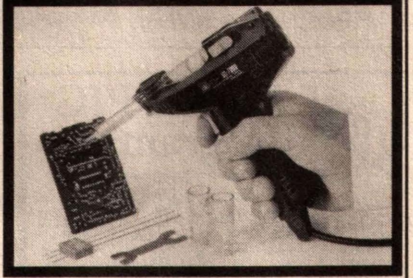

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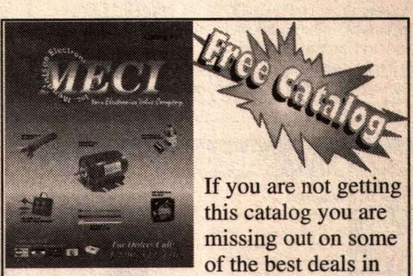

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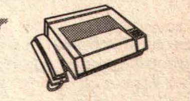

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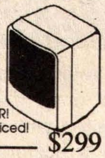

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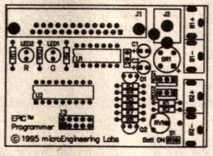

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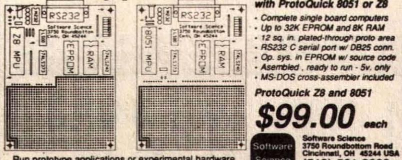

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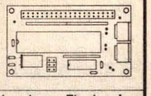

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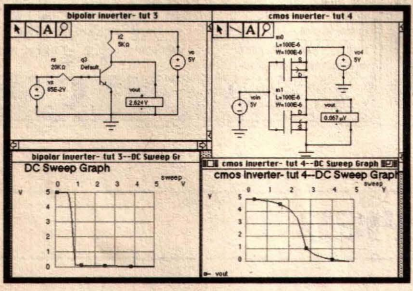
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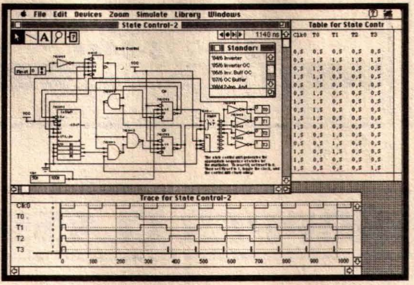
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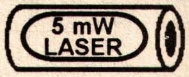

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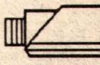

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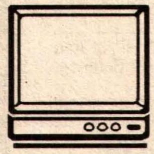

approx. dimensions : camera 2-1/2" x 4-1/4" x 8"
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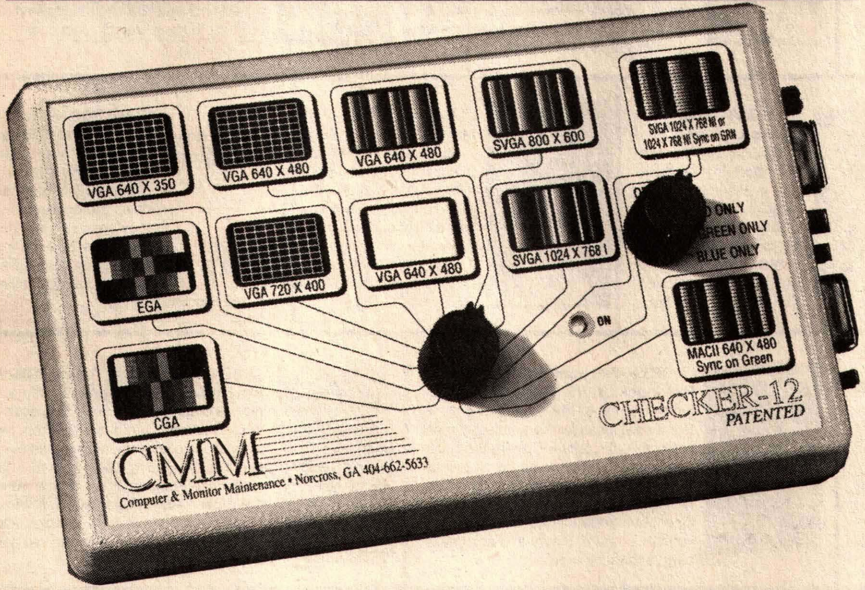

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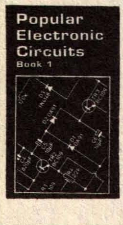

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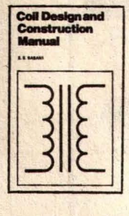

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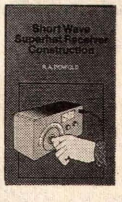

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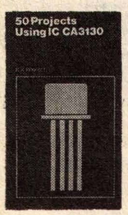

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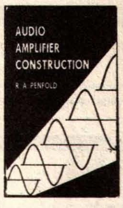

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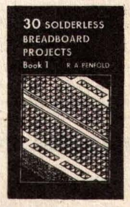

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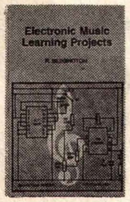

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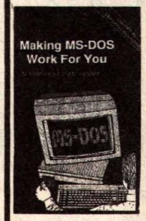

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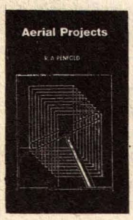

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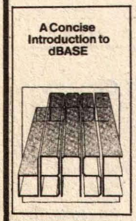

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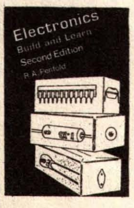

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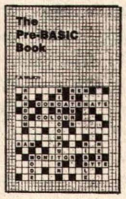

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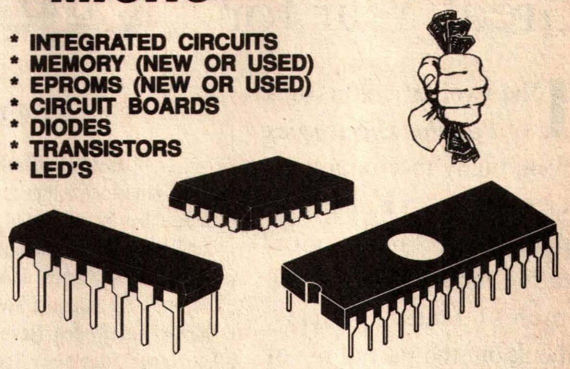

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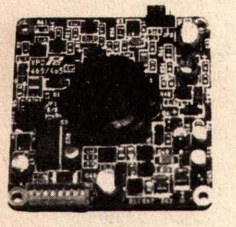

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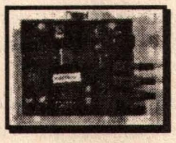

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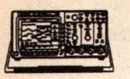

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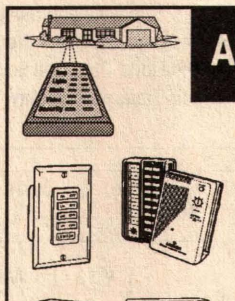

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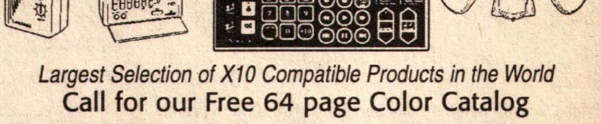

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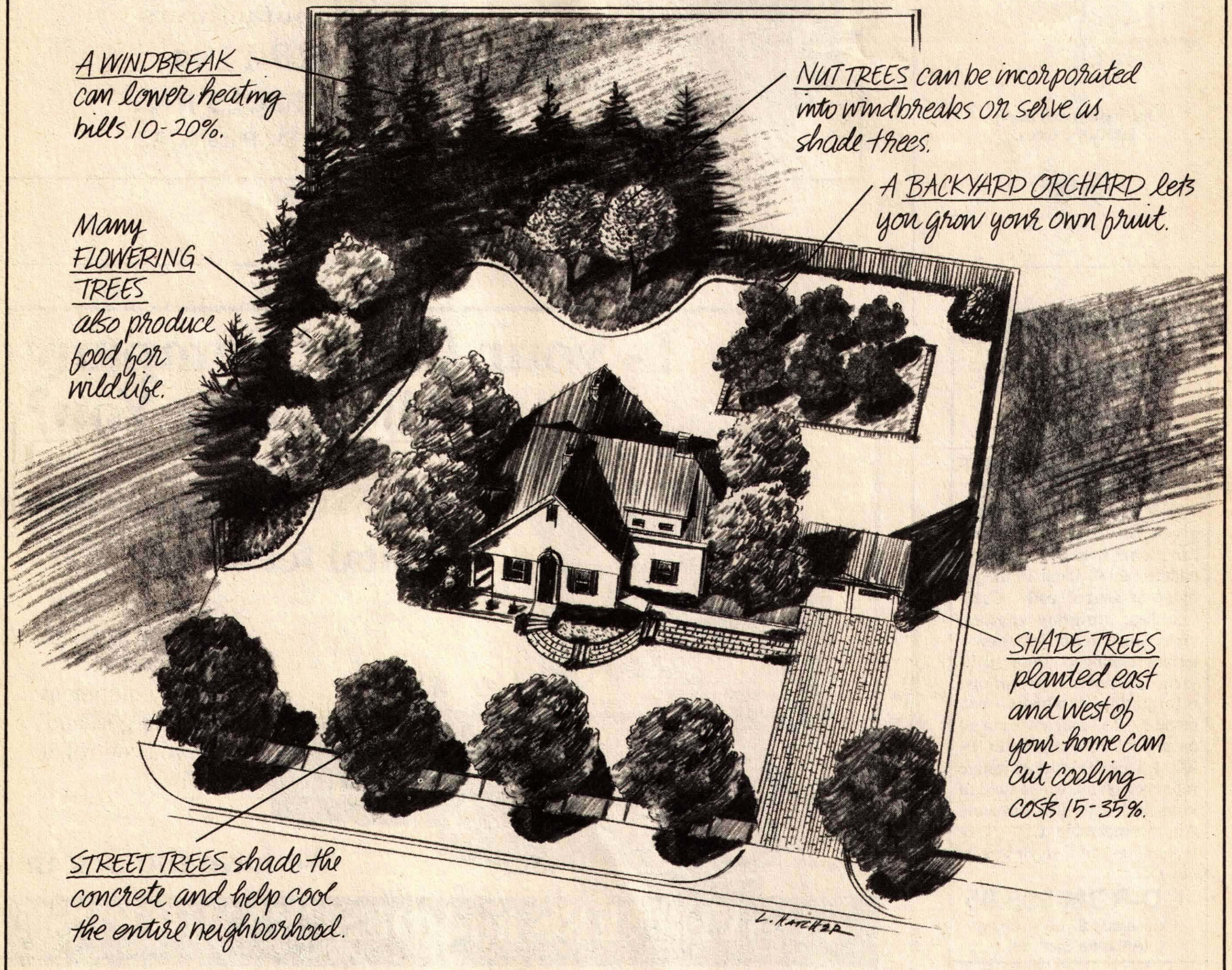

A WINDBREAK can lower heating bills 10-20%.

NUT TREES can be incorporated into windbreaks or serve as shade trees.

A BACKYARD ORCHARD lets you grow your own fruit.

Many FLOWERING TREES also produce food for wildlife.

SHADE TREES planted east and west of your home can cut cooling costs 15-35%.

STREET TREES shade the concrete and help cool the entire neighborhood.

America needs more trees

The United States has lost a third of its forest cover in the last 200 years.

Our towns should have twice as many street trees as they have today.

We need more trees around our homes and throughout our communities. We need more trees to protect our farm fields and our rivers and streams. To provide wood for our homes and a thousand products we use every day.

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Here's how you can participate. When you join the Arbor Day Foundation you will receive ten free Colorado blue spruces, or other conifers selected to grow in your area.

Colorado blue spruces have silver, blue-green color and compact conical shape. Spruces can be planted as a privacy screen, as an energy-saving windbreak, as individual ornamentals, or as living Christmas trees.

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20 character x 16 line $79.00 or 2 for $149.00

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20x4	$25.00	16x2	$8.00	40x2	2 for $25.00
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Ability to do 40 and 80 column.

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Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V)

Chip size 10.7 (H) x 9.3 (V) mm^2 • Unit cell size 23.0 (H) x 13.4 (V) um^2 • Ceramic 24 pin DIP package. • Mfr: Sony, Part# 016AL

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HACKER CORNER

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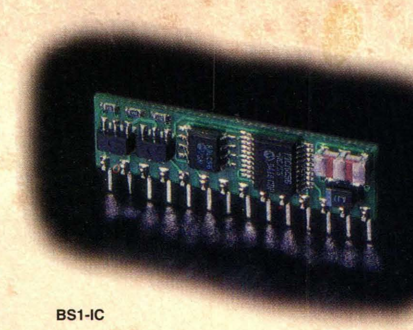
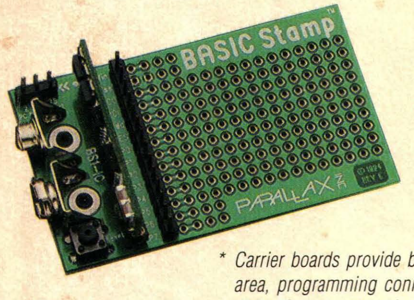
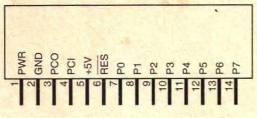




BASIC Stamp I Module (BS1-IC)

8 general-purpose I/O lines
256-byte program space (100 instructions)
4-MHz clock (2400 baud serial, etc.)
$34, $54 with carrier board*

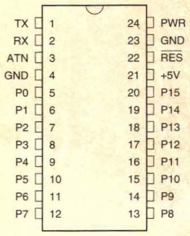
BS1-IC



1 PWR
2 GND
3 PCO
4 PCI
5 +5V
6 RES
7 P0
8 P1
9 P2
10 P3
11 P4
12 P5
13 P6
14 P7

** Carrier boards provide battery clips, prototyping area, programming connector, and reset button (BS1-IC carrier shown).*

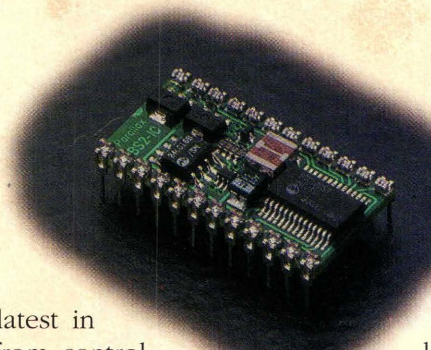
BS2-IC



TX 1
RX 2
ATN 3
GND 4
P0 5
P1 6
P2 7
P3 8
P4 9
P5 10
P6 11
P7 12
24 PWR
23 GND
22 RES
21 +5V
20 P15
19 P14
18 P13
17 P12
16 P11
15 P10
14 P9
13 P8

BASIC Stamp II Module (BS2-IC)

16 general-purpose I/O lines
2048-byte program space (600 instructions)
20-MHz clock (9600 baud serial, etc.)
$49, $69 with carrier board*



These new BASIC Stamp modules are the latest in BASIC Stamp computers. They're perfect for numerous applications, from controlling model trains to monitoring factory sensors. They have 8 or 16 I/O lines, which can be used for a variety of digital and analog purposes. And like the original BASIC Stamp, these modules are programmed in BASIC. Our special "PBASIC" language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as SBC instructions for serial I/O, pulse measurement, and button debounce.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cables, manuals, application notes, and free technical support. The package is available for $99; Stamps must be purchased separately.

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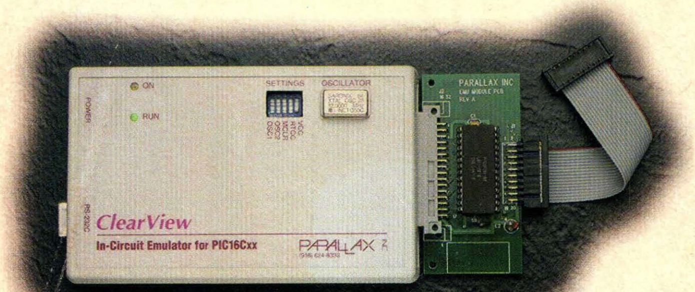

ON
RUN
POWER
SETTINGS
OSCILLATOR
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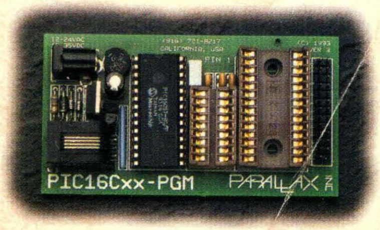

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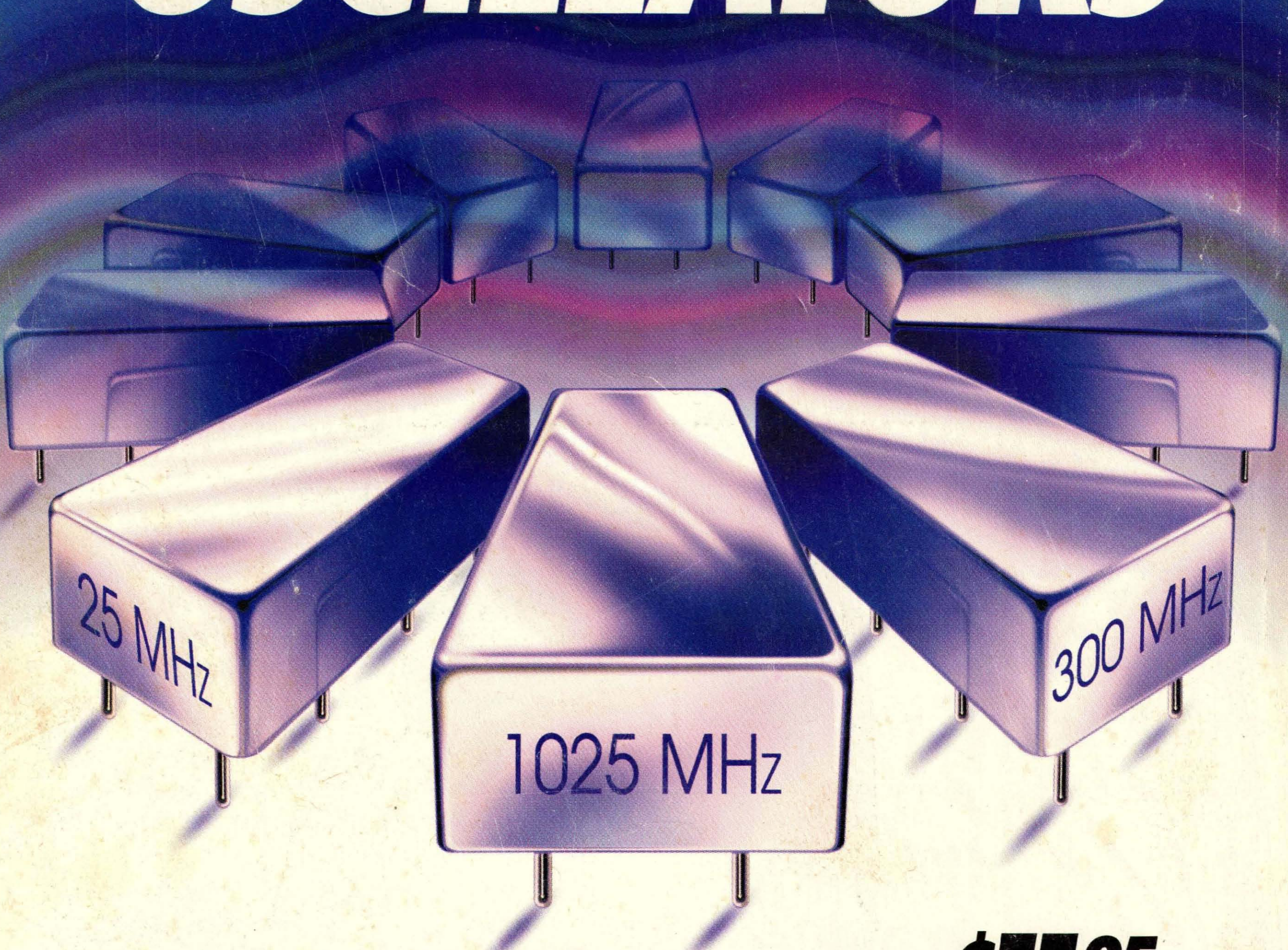

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POS-75	37.5-75	-110	-27	17	11.95
POS-100	50-100	-107	-23	18	11.95
POS-150	75-150	-103	-23	18	11.95
POS-200	100-200	-102	-24	18	11.95
POS-300	150-280	-100	-30	18	13.95
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